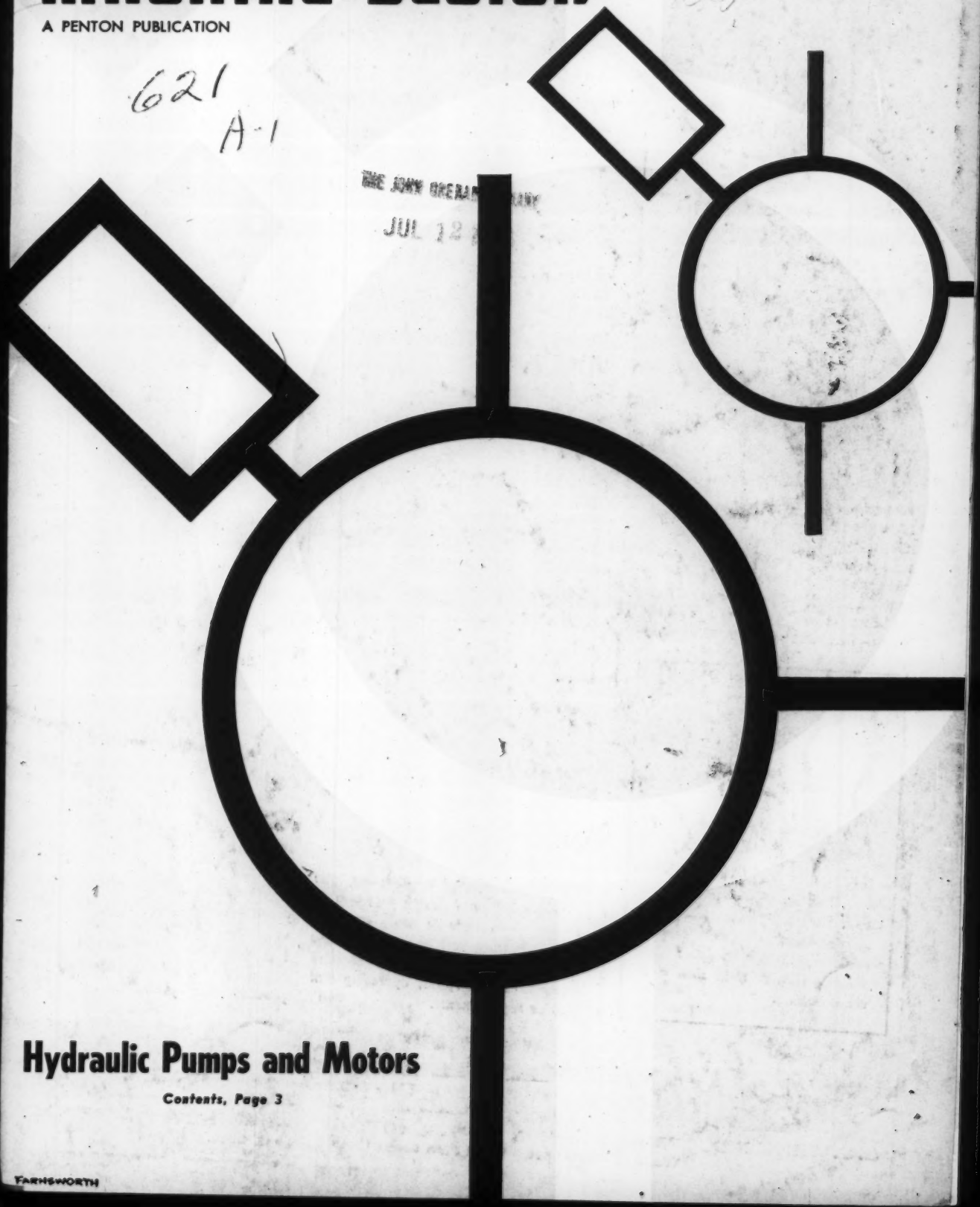
JULY 12, 1956
EVERY OTHER THURSDAY

MACHINE DESIGN

A PENTON PUBLICATION

621
A-1



Hydraulic Pumps and Motors

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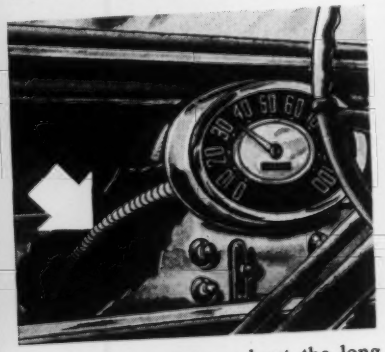
FARNSWORTH

FLEXIBLE SHAFT IDEAS for ENGINEERS

For driving or controlling inaccessible parts flexible shafts do a better, more economical job

Fewer design problems, better placement of elements, easier assembly are a few of the advantages

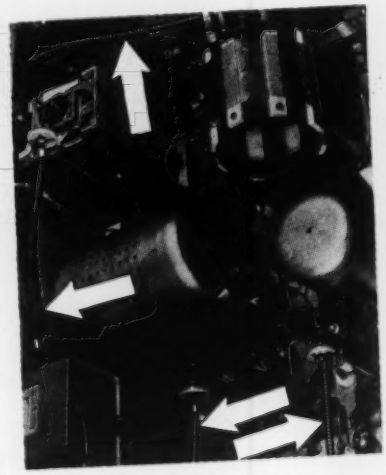
250,000 miles at 90 mph and still going strong



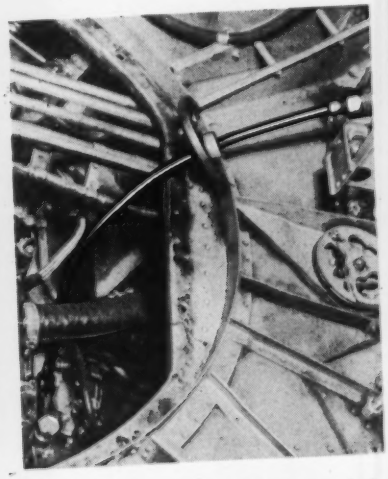
To prove our claims about the long life and dependability of S.S.White flexible shafts, we conducted accelerated life tests on a number of S.S.White speedometer shafts. After being run at 90 mph for 250,000 miles—the equivalent of being "driven" 10 times around the world—the shafts were still going strong.

Here is information every designer should have

Bulletin 5601 contains the latest information on flexible shafts. Included are full details on how to select and apply power drive flexible shafts as well as up-to-date tables showing flexible shaft sizes and characteristics.



In this electronic circuit, flexible shafts run between variable elements and control knobs give extra freedom in locating parts to best advantage.



A flexible shaft can be easily run around obstructions from one point to another as in this aircraft tach generator drive.

The Ready Adaptability of S.S.White flexible shafts in meeting varying design requirements makes them one of the most versatile elements available. And nowhere does this adaptability count for more than in providing an efficient, low-cost drive or control for parts that must be mounted in hard-to-get-at locations.

For remote control applications, this means additional design freedom in mounting controls in more advantageous operating positions. It also means more efficient placement of controlled parts to satisfy space, operating and service requirements.

As for transmitting power, using a flexible shaft to couple a driven part directly to its driving unit eliminates the need for additional parts such as universals, straight shafts and gearing. It provides a more efficient, quieter drive which needs no alignment and which can be installed faster, with fewer problems.

S.S.White flexible shafts are made in a large selection of sizes and characteristics to enable you to meet a wide range of application requirements.

Full engineering cooperation in selecting and applying flexible shafts to your products is always available.

F6-7

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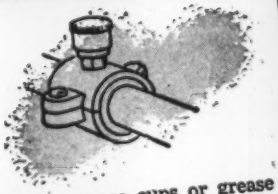
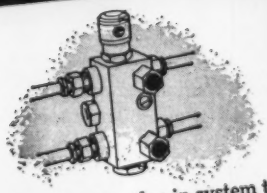
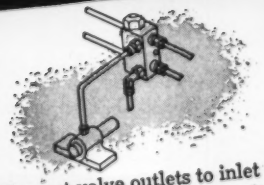


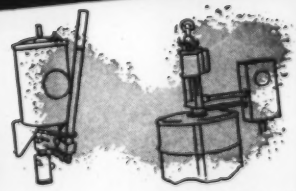
1. Remove grease cups or grease fittings.



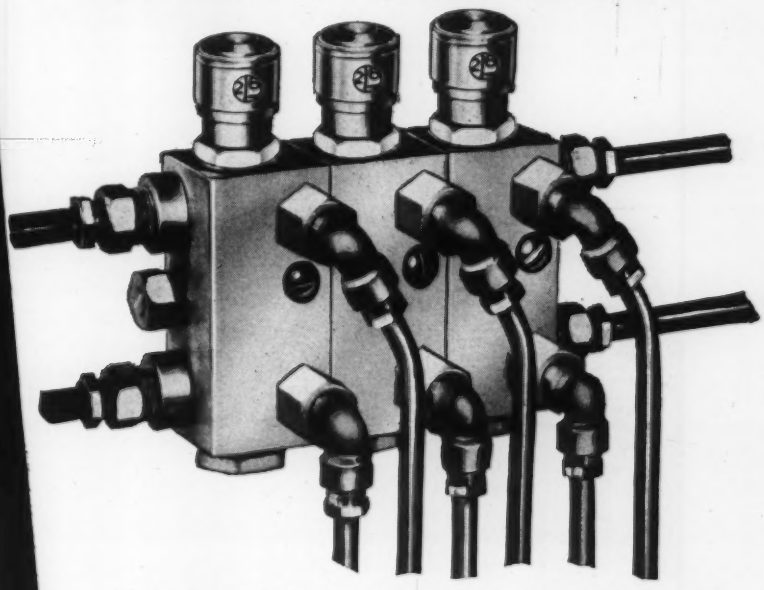
2. Connect each valve in system to its two lubricant supply lines.



3. Connect valve outlets to inlet of bearings. (Each valve serves two bearings.)



4. Provide central pump for supplying lubricant to system.



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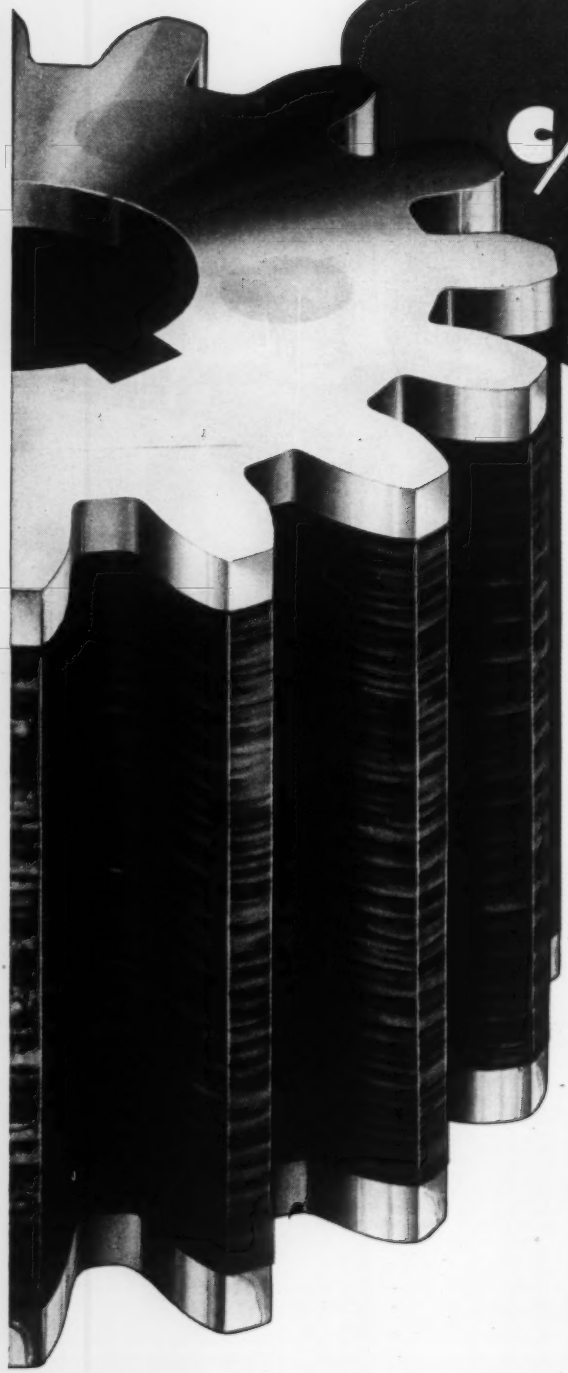

Do you know what C/R RAWHIDE GEARS can do for you?

HERE'S WHAT—They will transmit power quieter, with less vibration than other types of gears. These tough, resilient Rawhide gears will absorb momentary overloads up to 3 times their rated H.P. capacity . . . protecting expensive metal gears. Since C/R Rawhide pinions cause negligible wear, they actually prolong the life of mating metal gears.

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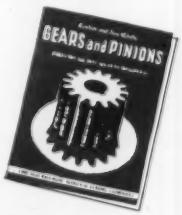

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THE PROFESSIONAL JOURNAL
FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

July 12, 1956
Volume 28—No. 14

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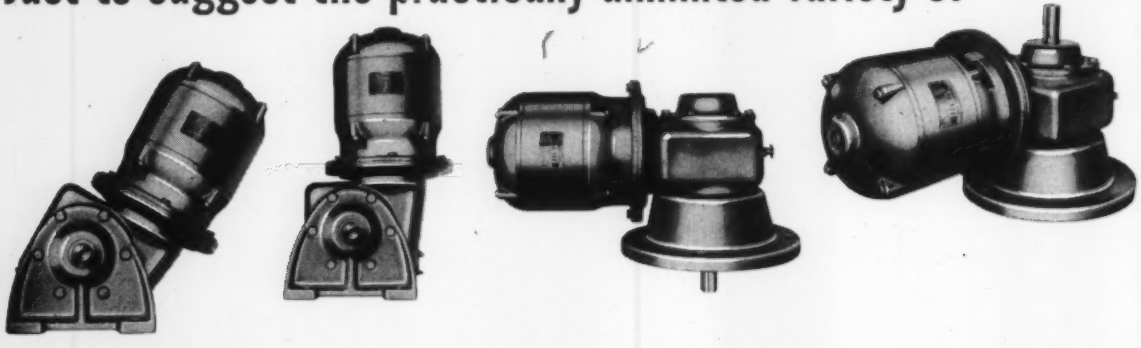
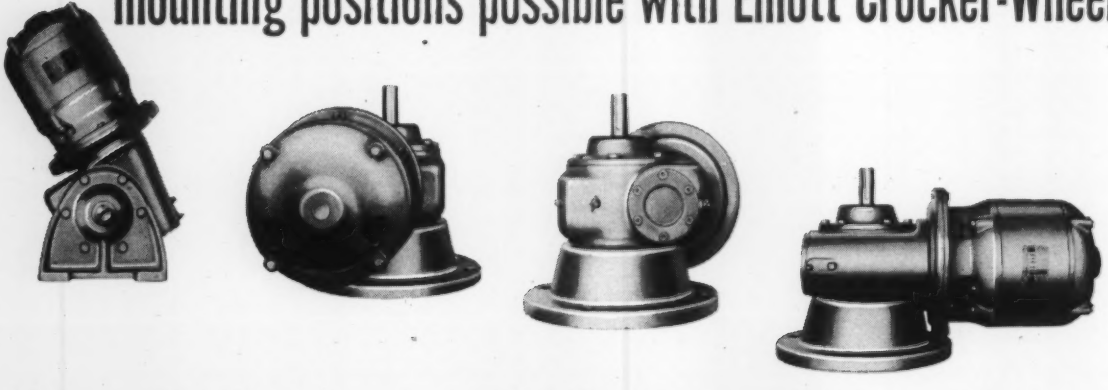
Just to suggest the practically unlimited variety of



mounting positions possible with Elliott Crocker-Wheeler



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XUM

Engineering News Roundup

Language Translating Machines Seen Possible Soon

Key Problems Are Costs And the Language Itself

SAN FRANCISCO, CALIF.—"There appear to be no insurmountable engineering problems in the realization of a mechanical translating machine," R. E. Wall, Jr., of the University of Washington, said recently. Mr. Wall spoke at a computing symposium at the Summer and Pacific General Meeting of the American Institute of Electrical Engineers. A number of engineering problems remain to be solved he said, but most of the work leading to a practical machine is linguistic in nature.

At the time mechanical translation of language by digital processing equipment was suggested in 1946 by Donald A. Booth and William N. Locke, the necessary computer components were not available. Recent advances in computer technology, however, make mechanical translation "a definite possibility provided certain limitations are made in the type of material which will be fed into the machine, and also if certain allowances are made in the required quality of the output material."

"It seems likely that such a machine will cost as much as a modern large-size digital computer which has a per-hour cost of about $250," he said. "Human translators will produce rough, understandable translations for a per-word cost of about one cent. This means that a $250 per hr machine would have to produce about 25,000 words per hr in order to have a same per-word cost. This figure is, of course, somewhat arbitrary, but it is certain that one word per second is too slow, and one hundred words per second is probably faster than necessary."

TILTABLE WING of a proposed research aircraft moves forward from its vertical takeoff and landing position to a horizontal position for flight. The plane, to be built under military contract by Vertol Aircraft Corp., will have a single turboprop engine geared to two rotor-propellers mounted on the wing tips. The Army hopes to eliminate its need for landing fields.

Engineers Plan Consolidated Air-Auto Drafting Standard

Progress To Date Noted And Objectives Set

NEW YORK, N. Y.—The Society of Automotive Engineers has announced that it will undertake to prepare a drafting standards manual which will combine the most widely accepted practices in the aeronautical and automotive industries.

It is expected that the results of this project will be important factors in revisions of military drafting standards and the drafting standards manual of the American Standards Association.

Progress in air-auto drafting consolidation has already been made. In 1950, separate SAE committees for air and auto drafting standards had agreed on abbreviations of terms used on drawings. In 1954 a joint subcommittee completed a standard of dimensioning and tolerances.

Subjects to be covered in the latest drafting standards project are:

1. Improvement of geometric and positional tolerancing standards. This is the keystone of drafting standardization since it affects interchangeability.

2. Simplification of drafting practices. The joint committee is recording some of the short cuts and simplified drafting practices now widely used in industry.

3. Investigation of the trend to

eliminate specifying how to process a product on engineering drawings, thereby allowing maximum flexibility in the use of manufacturing methods and equipment.

4. Encouragement in the use of decimal dimensioning.

5. Standardization in the method of specifying screw threads. Particular emphasis will be placed on threads which are special, modified, coated, or plated, and those having special lengths of engagement.

6. Development of new drafting techniques for use in preparing drawings that are intended to be reduced in size.

7. Development of a standard method to specify on engineering drawings how to control free-state variations in the shape of sheet-metal parts.

JET ENGINE SIMULATOR is this G-E analog computer, one of the world's largest. It contains 6000 vacuum tubes, 27 miles of wire, 1700 indicator lights, a 150 hp motor and four generators which develop 103 kw. It can simulate operation of engines at 20,000 ft altitude, −40F and speeds to 1260 mph.

Tough New Synthetic Foam Rivals Performance of Rubber

ALLIANCE, O.—A new cushioning material, tough but light in weight, has been introduced recently by Armour and Co. The new product is called Armofoam.

A pull of 9 to 11 lb is required to tear a ½-in. piece. A pull of 12 to 15 psi is needed to pull it apart. The tear strength of Armofoam is about 2½ times greater than natural foam rubber. Armofoam can be sewn, and stitches will not pull out upon stretching. Thin sections of Armofoam can be used in many unsupported applications.

A piece of this material which measures 24 by 25 by 4 in. weighs only 2 lb. A foam rubber piece would weigh about 5½ lb. This feather-weight characteristic should mean increased freight loads for many types of transportation carriers.

Armofoam is solvent resistant. Laboratory tests indicated good resistance to swelling in most chemical compounds, oils and water. The material is also said to be resistant to kerosene, benzene and carbon tetrachloride.

A load of 0.4 to 0.5-psi is required to reduce Armofoam thickness 50 per cent. Besides being used as a cushioning material, Armofoam can be used to absorb dynamic shock, to insulate, and to control noise.

General-Purpose Computer Has New Miniature Parts

Small Parts Save Space, Permit High Speeds

BEDFORD, MASS.—A new high speed, general purpose electronic computer built by Remington Rand for the Air Force Cambridge Research Center features two recent developments in the miniaturization of computer components. The computer uses tiny pulse-amplifying devices known as Ferractors in its magnetic-core circuitry and a small magnetic drum in the memory unit.

The Ferractor itself is primarily a minute ring of metal, roughly spool-shaped. Another strip of metal is set around the outer circumference, something like an iron tire on a wagon wheel. The whole thing is wrapped radially with fine, insulated wire.

About 40 of these spools would fill a jumbo peanut shell. The smallest vacuum tube in a radio set could hold dozens of them. The "wagon tire" strip is the thinnest metal ever rolled in the history of metalworking. Gold-leaf, the only thinner metal in existence, is beaten thin, not rolled.

Two Ferractors, each replacing an old-style vacuum tube, are sealed within a casing like a pill box, about ⅝-in. in diameter and a little less than ¼-in. thick. Four "pill boxes" are mounted on thin plastic cards, each about the size of a postcard, along with a number of resistors and a line of midget diodes.

The cards fit into the front of the computer, set edgewise. Each card, or package, makes contact with many fixed points at the back, actually tiny wires with fitted

Front Cover

The colorful circles on our front cover this issue are not intended to represent the three rings of a well-known brand of beer. They are hydraulic pumps, treated in symbols by cover artist George Farnsworth. Article providing the theme is the Data Sheet by Howell C. Lowe.

You Need It!

The boom in production means more pressure than ever for engineering prints. A new, modern reproduction unit with higher speeds, more operator conveniences will help you deliver them.

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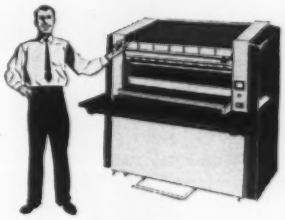

Take this opportunity to replace that old, inadequate reproduction machine with the efficient new unit you've been wanting—a faster, better engineered, and trouble-free *modern* machine!

You'll Surely Get Management Approval!

If your firm, like most, is gearing up for greater-than-ever production, you couldn't pick a better time to get the approval of management for new, modern, higher-production equipment.

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To meet production's push for more engineering prints, you couldn't pick a better time to get a new, modern reproduction machine. And you couldn't make a wiser choice than efficient, trouble-free Copyflex!

In just the last year, Bruning has introduced five new, advanced machine models, one of which is shown at the right. These machines offer you the famous problem-free installation and operation of Copyflex . . . no exhaust venting, no plumbing or auxiliary equipment, no installation other than an electrical connection. They bring you faster reproduction speed and a host of operator conveniences such as fast return of originals, automatic separation, front or rear delivery. They are efficient, economical, modern reproduction machines that will help you boost your drafting room output, keep costs at a minimum.

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ends resembling telephone operators' cord plugs, except that they are less than ½-in. long. Each plug fits into a "jack" just tightly enough to stay put. About 600 such cards, plus a few ordinary transistors, form the main working portion of the computer along with the high-speed magnetic drum.

The drum consists of a cylinder, 5 in. in diameter and 3 in. in length, spun by a small motor at 16,500 rpm. Its bearings are ground to a mirror finish within 0.0001-in. The drum receives and retains magnetic impulses imprinted by "writing heads" set 0.001-in. off the nickel-cobalt coating.

The whole drum is sealed in a box-like metal casing about a cubic foot in size and filled with helium. The helium reduces frictional resistance due to the high speed with which the drum revolves. In addition, helium carries off heat faster than ordinary air, allowing the drum to run considerably cooler. Significant heating would cause the drum ultimately to expand enough to result in actual contact with the head.

In electronic engineering terms, Univac Magnetic uses a "parallel bit serial digit code at a 660 kc/ sec bit rate, which allows the addition of two 10-digit numbers in 90 microseconds, over 11,000 additions per sec, and multiplication in from 0.3 to 1.7 milliseconds, over 3000 multiplications per sec."

FULL OF HOT AIR, the pneumatic jet engine starter mounted on this truck delivers 125 lb per minute of air at 55 psi and 550 F. It starts a jet engine in less than 30 seconds, then automatically unplugs itself from the plane. The air travels through a 30-ft long flexible hose stored on a reel in the truck body. Constructed as a box-frame with removable panels, the starter unit consists of a gasoline engine-driven two-stage compressor. It was built by Greer Hydraulics Inc.

TV Keeps Multiple Eyes on Steel Plate in Process

COATESVILLE, PA.—Looking around corners—several simultaneously—is the job of a new RCA TV monitoring installation at the Lukens Steel Co. here.

In the Navy alloy plate building, six cameras peer into critical blind spots on a furnace line, thereby enabling only one operator to control all the equipment at a distance. Three of the cameras are located on a large shear.

Together, the cameras enable complete and continuous observation of successive operations: the heating of plates, quenching, cooling and discharge operations, and shearing.

Topics

More cool cars will be bought in 1956 than during any previous year. Auto air conditioner sales are estimated at between 250,000 and 300,000 units; in 1954 about one-fifth this number were sold. One possible reason for the increase in popularity: Average price of air conditioners has dropped from $450 in 1955 to $350.

• • •

For cars without air conditioning, a screened window has been invented to keep insects out. Turning a crank moves the window glass down and the screen up simultaneously. For hand-signaling purposes, the motorist can open the window without raising the screen if he remembers to first disengage the crank from the screen mechanism.

• • •

Short-range jet transports are being considered for production by several major aircraft companies. The planes would carry about 60 passengers on medium-range flights. Maximum weight would be 140,000 lb—less than half that of 125-passenger, long-range jet airliners.

• • •

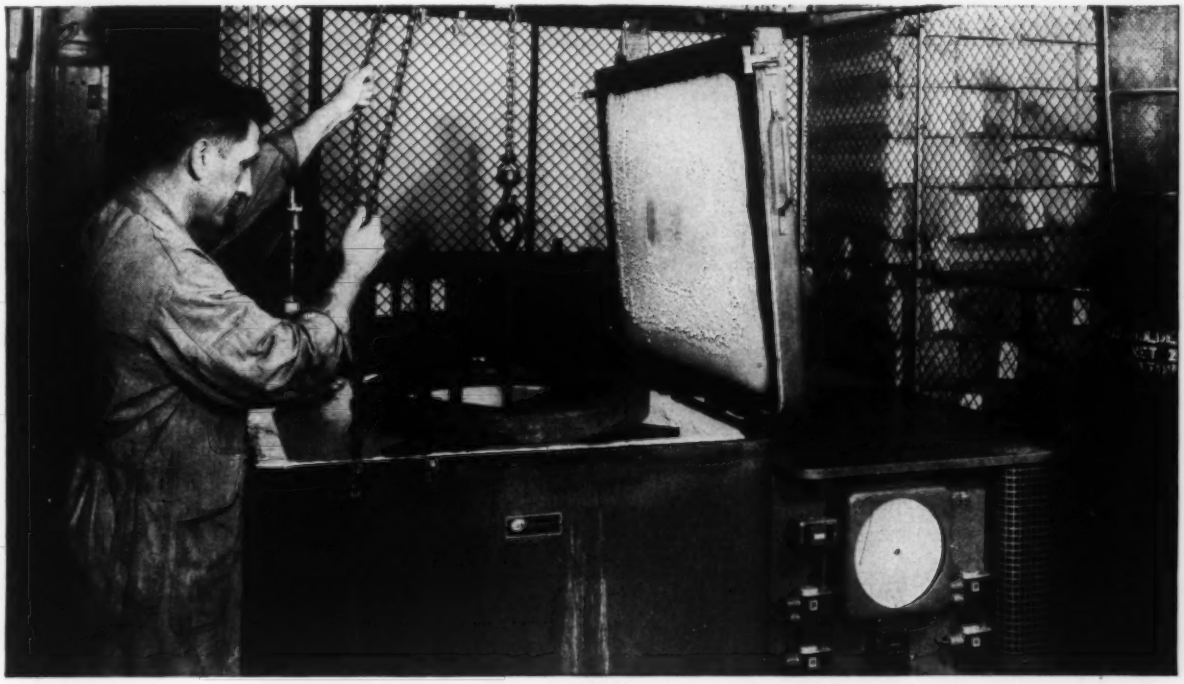
Door-to-door locksmithery is made possible by a key-duplicating machine developed by Yale & Towne Mfg. Co. When plugged into an automobile cigaret lighter socket, the machine duplicates pin and disk tumbler keys.

• • •

A bit of twig-bending to bolster the future supply of scientific personnel has been tried—successfully—by an Oklahoma oil company. Employees' teen-age children were permitted to use the company's research laboratory to work on projects of their own choice, such as the building of an electronic tachometer. The laboratory sessions steered several of the youngsters into engineering colleges.

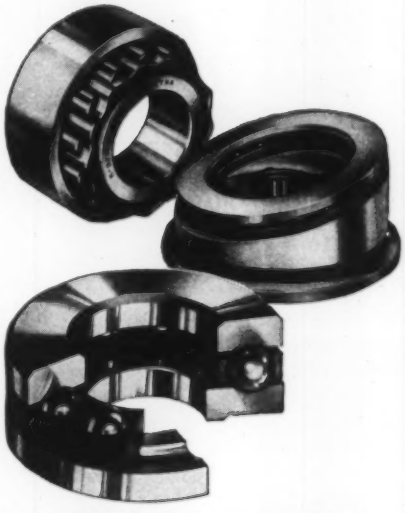
• • •

Chemical deicing compounds for aircraft are being developed for the Air Force by scientists at Armour Research Foundation. The compositions can be brushed, sprayed, or applied in the form of tape on areas where ice accumulates. One compound is for application during flight, to remove ice that has already formed.



AETNA FREEZES BEARINGS AT 130° BELOW ZERO

to give you better, more dependable anti-friction performance



Typical examples of Special Aetna Super-Precision Bearings . . . manufactured to the most advanced dimensional control standards including stabilization.

Looks warm and comfortable, doesn't he?—the operator pictured here. Actually he's only inches away from one of industry's coldest work spots—the "deep freeze" vault where Aetna bearing components are treated at temperatures as low as 130 degrees below zero.

This special sub-sub zero treatment makes certain that vital Aetna bearings built into high precision products will provide the dimensional stability so necessary for sustained peak efficiency and longest life expectancy. In this quick-aging process the steel's metallurgical structure undergoes transformation—from the relatively soft austenite retained from heat treating into the much harder, tougher, fatigue resisting property, martensite. The result is a stabilized bearing that permanently holds it precise tolerances and assures the lowest possible coefficient of friction no matter how severe or varied the operating temperatures may be.

We call this the "cold war" against friction—one of the many advanced ways and reasons Aetna consistently produces anti-friction products that lead the field in dependability and cost-cutting efficiency.

Perhaps stabilization can solve a stubborn bearing application problem for you, too. Aetna's technical staff is ready to help you investigate. Why not outline your problem for their study?

Aetna

AETNA BALL AND ROLLER BEARING COMPANY

Division of Parkersburg-Aetna Corporation

4611 SCHUBERT AVENUE • CHICAGO 39, ILLINOIS

Manufacturers of: Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Radial Ball Bearing Mounted Units • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Parts

—ITEM 508—

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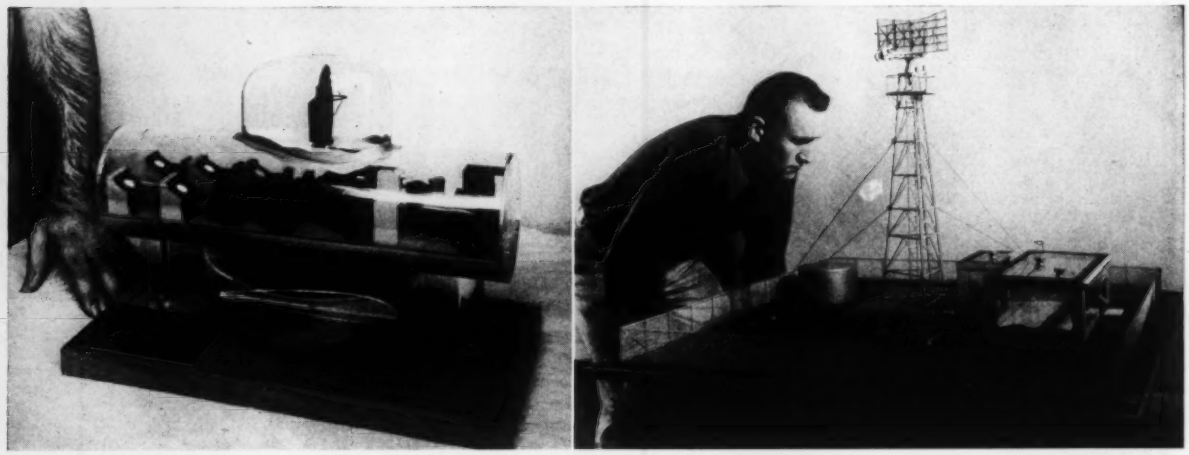
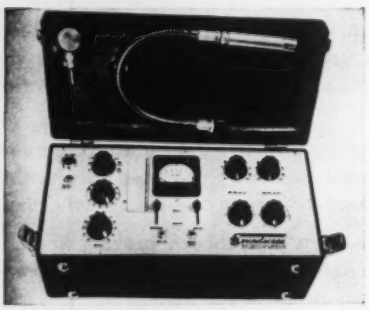


MODELS OF A RADAR AIR DEFENSE SYSTEM are accurate replicas of the Semi-Automatic Ground Environment (SAGE) installation now in operation. Airborne radar for circling the offshore perimeter of the SAGE system was developed from scale models such as the one at upper left. Low-flying aircraft that come in under the beam of the long-range search radar of the system are detected by gap-filler installations like the model at upper right. This replica of an unattended low-altitude radar is complete, even to the wire fence around the installation. Test model of a long-range search radar unit is shown at right. The full-sized installation of this antenna picks up and transmits early warnings to the direction center, a windowless, reinforced concrete building which houses a dual-channel computer. The models were made by Atkins & Merrill Inc.

Small Portable Instrument Measures and Analyzes Noise

PITTSBURGH, PA. — A small electronic instrument has been introduced by Mine Safety Appliances Co. as the first to combine four principal functions necessary to measure and analyze noise accurately. The compact 20-lb Soundscope accomplishes noise analysis which would normally require four individual units.



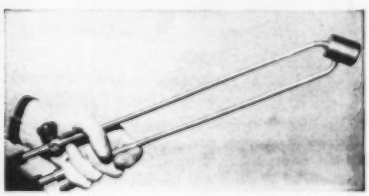
The instrument functions as a meter to measure overall sound levels and as an analyzer to determine noise peaks. It can also check sounds in narrower frequency bands. Electrical and acoustical calibrators are built in.

Measurement range is from 24 db, which is about that of a very quiet home, to 150 db, which is higher in sound pressure than an air-raid siren. In the analyzer section, noise is filtered into one of eight principal octave bands, from 75 to 19,200 cps. The instrument measures 16 in. long, 7¾ in. wide and 7 in. deep.

Auto racing in the basement is possible with a miniature track and cars developed in Great Britain. The cars are 12-in., handmade scale models of famous racing cars. They are powered by miniature diesel engines that enable them to reach a speed of 60 mph. Each car has a beveled gear box in the back axle and a centrifugal clutch fitted with tiny friction linings. The track accommodates as many as eight cars. An electric panel records and registers the lap performances.

New Gas Torch Is Quiet Worker

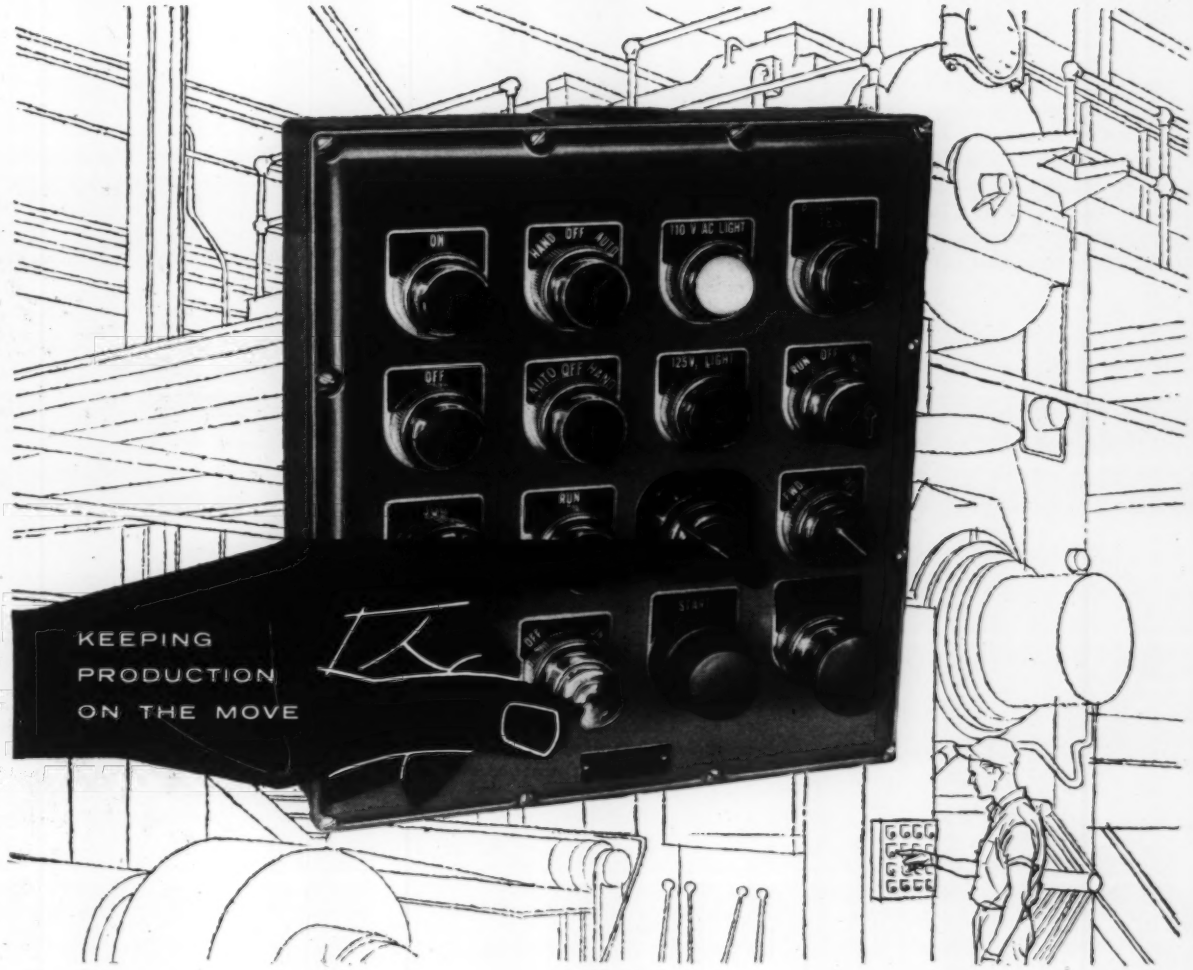
HELLERTOWN, PA. — A noiseless, lightweight hand torch developed by the Bethlehem Apparatus Co.



is said to be the hottest low-pressure gas-oxygen hand torch yet made. It is expected to be particularly useful in the glass-working trade and to have wide application in metalworking where rapid heating of localized areas is required.

Known as the Polymix torch, the new device can be held and

XUM



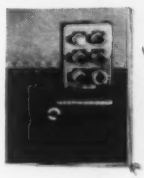
. . . with Westinghouse Oil-Tite control stations—1 to 16 units

Interchangeable parts — stations, contact blocks, operators and indicating lights — right off the shelf, quickly give you a "tailor-made" Westinghouse Oil-Tite* control station to meet the requirements of any heavy-duty industrial equipment application.

Enclosures — die-cast and Bonderized — include cork-neoprene gasketing and close machine fits as positive seals against exposure to oil, coolants, cutting compounds, water and other foreign matter.

*Trade-Mark

New Pushbutton Guide



For more facts on why it will pay you to standardize with Westinghouse control stations, get a free copy of the new *Pushbutton Guide*, booklet B-6749. See your nearby Westinghouse salesman or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30210

WATCH WESTINGHOUSE!

WHERE BIG THINGS ARE HAPPENING FOR YOU!

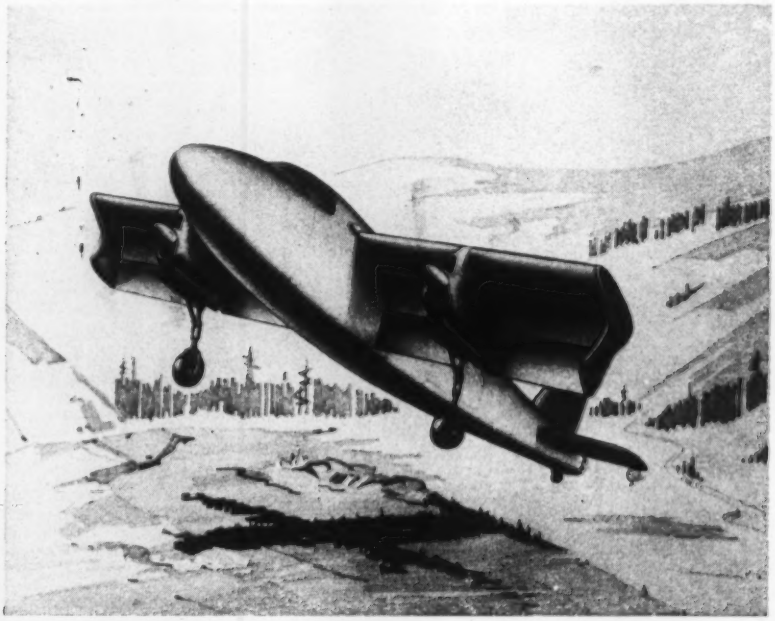
THERE'S A WESTINGHOUSE PUSHBUTTON TO MEET EVERY APPLICATION NEED!

—ITEM 509—

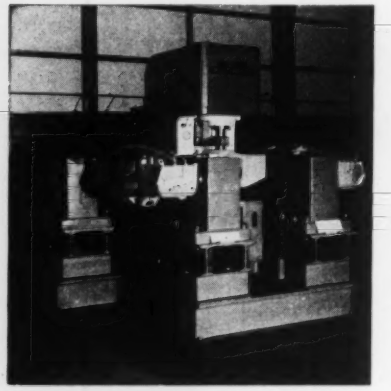
For More Information Circle Item Number on Yellow Card—page 19

used with one hand where necessary. Accurate control of flame is possible through two valves under the operator's hand. The flame can be changed at will from a small sharp flame of 1 or 2 in. to a wide, bushy flame covering a large area. Maximum length of flame is 18 in. with the entire flame area dense blue in color.

The torch operates with hydrogen, natural gas, mixed gas, propane or butane plus oxygen. It weighs 13 oz and is 17 in. long. At full flame, gas consumption is 40 cu ft per hour.



VERTIPLANE is this new craft to be built for the Army by Ryan Aeronautical Co. Intended for medium-speed liaison, light passenger and cargo transportation, Vertiplane will be able to take off straight up and land without a ground run. Performance will be achieved by employing deflected slipstream principle, using large propellers and double, retractable wing flaps.

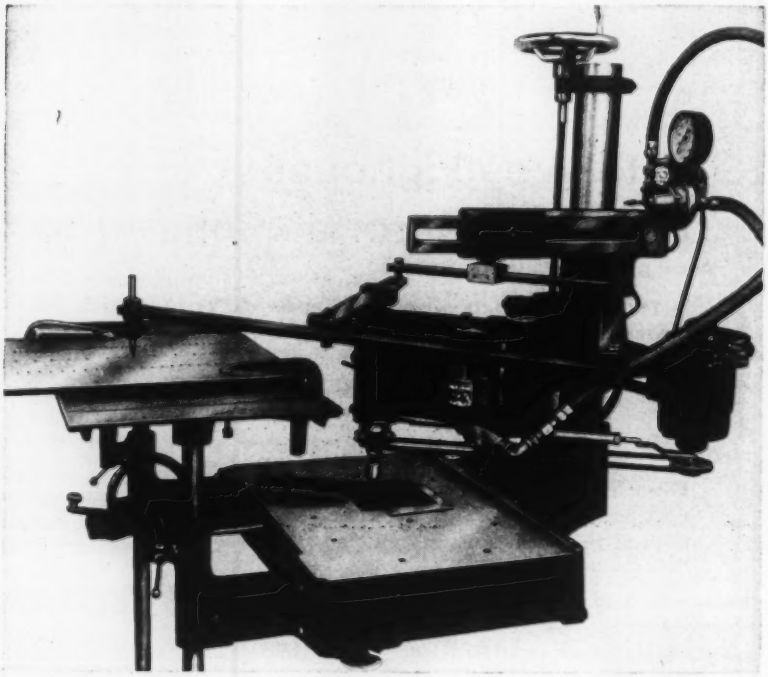


SIMULATING TEN YEARS' SERVICE in 30 days is the job of this 50-ton continuous cycling Multipress made by Denison Engineering Co. Here, the press is adapted to the testing of springs and snubbers on freight car trucks. Cycling 60 times per minute, the press delivers forces from 18 to 45 tons and works 16 hours per day. Formerly, the test used a drop hammer.

Free-Piston Gasifier is Dad to Family of Engines

DETROIT, MICH. — On display at the dedication of General Motors Technical Center, May 16, was the GM-14, a free piston gasifier, which is the parent to a growing and versatile family of new power plants.

GM-14 is the prototype of six free piston gasifiers which GM's Cleveland Diesel Engine Div. is supplying the Office of Ships Construction and Repair, US Maritime



FAST DRILLING MULTIPLE HOLES in printed circuit plates is the job of this New Hermes pantograph machine. A master template has dots connected by grooves through which operator guides stylus by hand. Stylus entering dot operates pneumatic drill feed automatically. Various hole sizes can be produced by using a routing cutter and circles in the template.

XUM

How flange surface conditions affect gasket compression

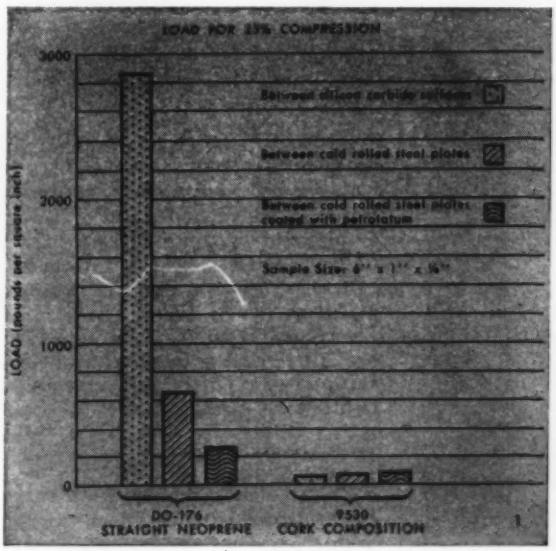
Some manufacturing processes deposit grease or oil on flange surfaces—others leave these surfaces smoothly finished. Naturally, under such varying conditions, certain types of gaskets may show unexpected load-compression characteristics.

Non-compressible rubber materials, for instance, slip badly on greasy or smooth surfaces. Thus grease, cutting oils, or a wet gasket cement can upset load calculations based on dry rubber placed between clean, non-skid plates. Compressible materials, however, are much less affected by slick conditions on flange surfaces.

Figures 1 and 2 show the comparative behavior of four different resilient materials under different surface conditions.

rubber gaskets

The first of these materials, Armstrong DO-176, (Fig. 1) is a straight neoprene compound. It requires a load of over 2,800 psi for 25 per cent compression



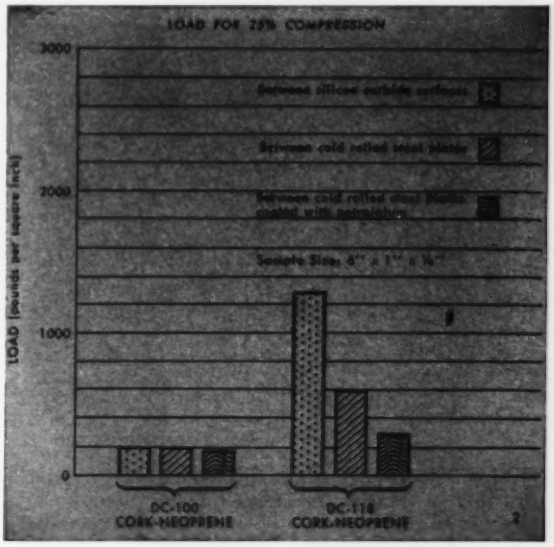
when gripped between rough ceramic surfaces. Between cold rolled steel plates coated with petrolatum, the load required for the same deflection drops below 250 pounds. Even without a lubricant, skid on smooth steel surfaces reduces the load required to slightly more than 600 pounds.

cork composition

With cork composition, a truly compressible material, varying surface conditions have little effect. As shown in Figure 1, Armstrong 9530 Cork Composition compresses 25 per cent with nearly the same load on a greasy surface as on a rough, dry surface. Maximum load variation is only about 3 pounds.

cork-and-rubber

By combining cork and rubber in varying amounts, compositions can be made whose behavior on slick surfaces falls between that of straight cork and that of straight rubber. Armstrong DC-100, for example,

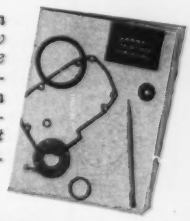


is a neoprene composition with a high cork content. As shown in Figure 2, load for 25 per cent compression on a greasy surface (160 psi) is only slightly less than on a rough surface (200 psi). On plain rolled steel plates, no slippage at all is evident.

Armstrong DC-118 (Fig. 2), on the other hand, contains relatively little cork. Load for 25 per cent compression drops from about 1,300 pounds on rough surfaces to 600 pounds for smooth steel plates. The same plates, coated with petrolatum, further reduce load to about 300 pounds. Other Armstrong cork-and-rubber compounds produce intermediate degrees of compressibility to meet particular needs.

SEND FOR 24-PAGE GASKET DESIGN MANUAL

You'll find other useful information on the design and use of gaskets in the new Armstrong Gasket Design Manual. Write for your copy to Armstrong Cork Company, Industrial Division, 7107 Dean Street, Lancaster, Pennsylvania. For information on all Armstrong Gasket Materials, see Sweet's product design file.



Armstrong

GASKET MATERIALS

. . . used wherever performance counts

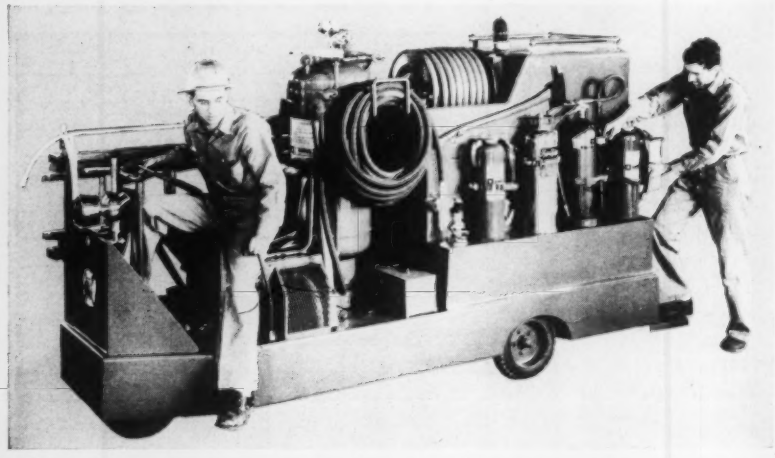
Administration.

A vestpocket version of this type of power producer is the free piston engine in XP-500, the new GM experimental passenger car.

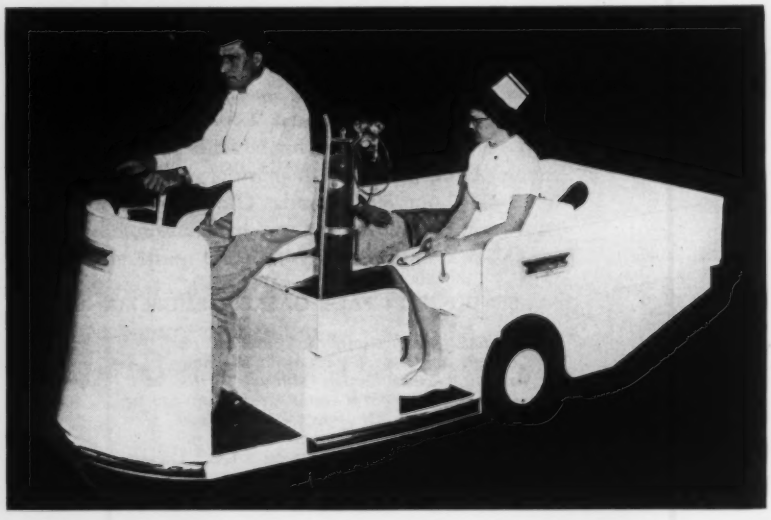
For almost three years GM Research Staff's Mechanical Development Dept. has tested GM-14. The unit has undergone scores of engineering modifications and has logged more than 7000 hours of endurance runs, consuming as much as 1000 gal per day of Bunker "C," lowest price petroleum fuel.

GM-14 was designed for ship propulsion or power station operation. It generates 1250 gas hp. In a single cylinder, two pistons that weigh 1145 lb each, bounce back and forth at approximately 600 cycles per min.

The engine's inherent balance is indicated by the fact that although it never has been bolted to the floor, it has never moved. It is simply mounted on a steel frame.



LITTLE SQUIRT for fighting fires inside industrial plants is this pint-size truck built by Ansul Chemical Co. The scaled-down equipment will go anywhere an ordinary plant lift truck can go. Overall height is 5 ft 8 in. Extinguishing agents are dry chemical, carbon dioxide and water. Accessories are ladders, hose, portable extinguishers and extra nozzles. Boots, air masks and a first aid kit go inside a cabinet, and a flashing red light goes on top.

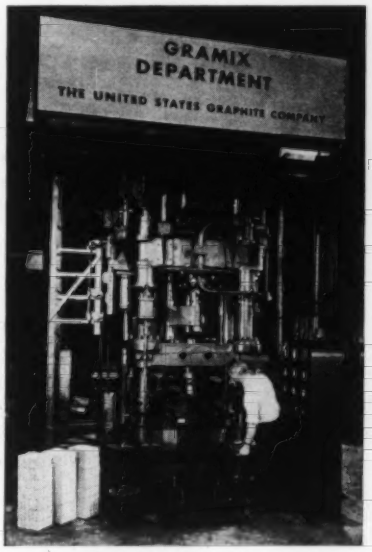


FAST FIRST AID is provided to injured industrial employees by the Westcoaster electric-powered ambulance, which operates on six heavy-duty batteries. Cushioned tires, coil springs and two shock absorbers assure a comfortable ride in this West Coast Machinery Inc. vehicle. Three-wheel design and sharp turning radius permit maneuverability in narrow corridors.

WIG-WAG FLASHER, designed to be seen by motorists traveling at high speeds, employs the attention-getting value of alternating light in a highway warning device. The flasher operates on power from a battery or a 110-v ac or dc line or generator and is claimed by Davis Emergency Equipment Co. Inc. to provide greater protection at about half the cost of a high-intensity, nonflashing signal.

Progress in electronics threatens to jeopardize New York City's reputation for hospitality to visiting dignitaries. Since stock prices are now flashed on boards rather than printed on ticker tape in most exchanges and brokerage houses, there is a shortage of the tape associated with parades in the big city. In the future, how-

ever, tape will be set aside for use in acknowledging the arrival of prominent visitors.



LARGEST MULTIPLE - ACTION PRESS for sintered metal bearings and parts is the first of its size ever used to compact parts from metal powders. The 300-ton automatic press will process larger parts on a production basis than was previously possible. It can produce parts having unusual design details, such as H-shape cross sections. The press was designed and built by Baldwin-Lima-Hamilton Corp. in conjunction with the engineering staff of the United States Graphite Co.

Caterpillar Co. Opens Biggest Tractor Plant

DECATUR, ILL.—The world's largest motor grader and wheel-type tractor plant was dedicated here the week of May 21-25 by Caterpillar Tractor Co.

The new plant is situated on a 425-acre plot of land northeast of Decatur. The two main buildings have more than 840,000 sq ft of manufacturing and office space.

Flexibility of manufacturing operations is built into the new Decatur plant. With the exception of extra height for heat treat and 34-ft high crane bays, the entire

(*Continued on Page 22*)

DARCOVA PUMCUPS

now available with

100% NYLON COMPOSITION

for HYDRAULIC CONTROLS, AIR CYLINDERS, RECIPROCATING PUMPS

DARLING Pumcups—long noted for unequalled efficiency and life in all kinds of cylinders—are now greatly exceeding their own performance records! The new 100% Nylon Composition, available *only* in Darcova Pumcups, does it!

Nylon Pumcups are made in sizes, types and textures exactly right for your particular equipment—ready *now* to give you unprecedented piston packing performance!

Write for helpful data Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.

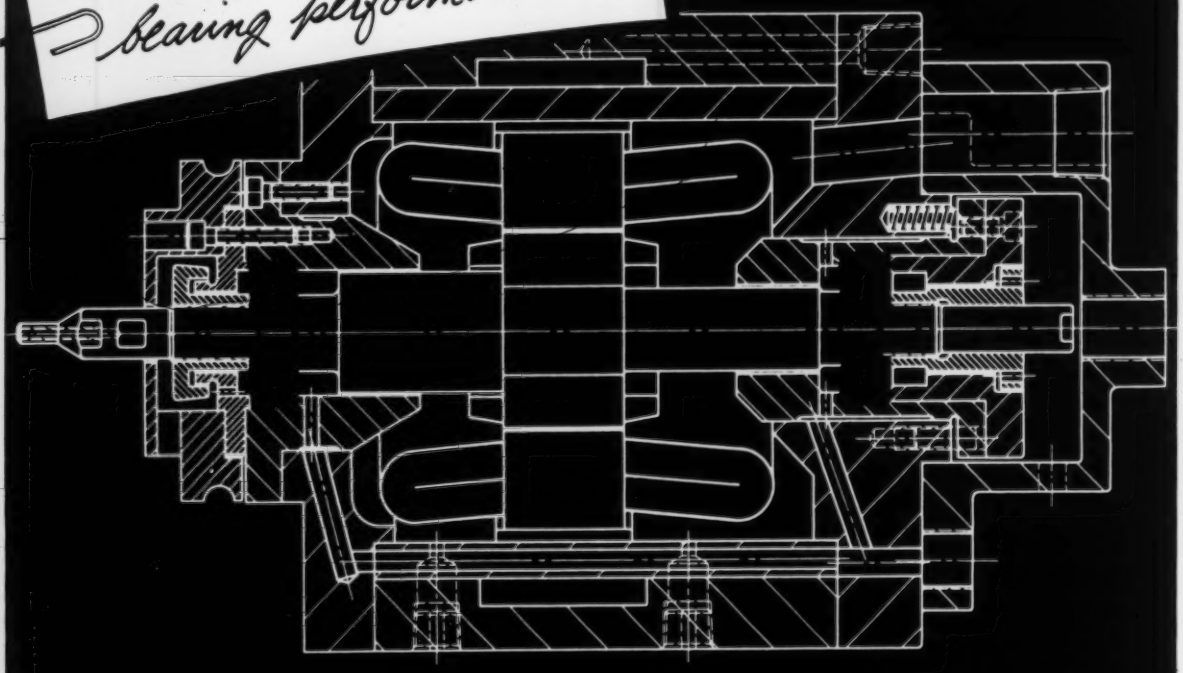
Williamsport 30, Pa.

DARCOVA TRADE MARK THE ORIGINAL COMPOSITION CUP

TRADE MARK PUMCUPS

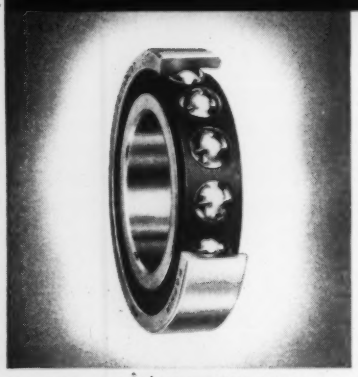
—ITEM 511—

Looking for improved bearing performance?



over 14 billion revolutions...

— and still going strong



Fafnir Super-Precision MM201W1-CR spring-loaded ball bearing, the type specified for wheelhead illustrated.

Fafnir-equipped, high-speed, oscillating grinder wheelhead demonstrates machine tool progress in performance

This extraordinary record has been made on the production line by a Pope-built wheelhead, grinding the races of extra-precision ball bearings. The hi-frequency motorized wheelhead operates at 72,000 rpm. The motor is water-cooled and bearings lubricated by means of an oil-air mist system.

When designing this oscillating grinder wheelhead, Fafnir engineers worked together with the Pope Machinery Company engineers in the selection and application of bearings. The type of bearing recommended is shown at the left and its application in the drawing above. Its performance record, according to Pope, demonstrates progress to match today's improved machine tools.

Whatever your bearing problem, a few minutes spent with a Fafnir representative may be the means of solving it as successfully. Write The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR
BALL BEARINGS

MOST COMPLETE LINE IN AMERICA

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MACHINE DESIGN
READER SERVICE

Reader Information Service

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Vibration control in welded structures, Edit. 103

Washers, Edit. 144; Adv. 60
Welding, Adv. 64
Wire and wire products, Adv. 186

Zinc and alloys, Adv. 74

USE A YELLOW CARD *for More Information . . .*

CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

Index to New Parts & Helpful Literature

BY ITEM NUMBERS

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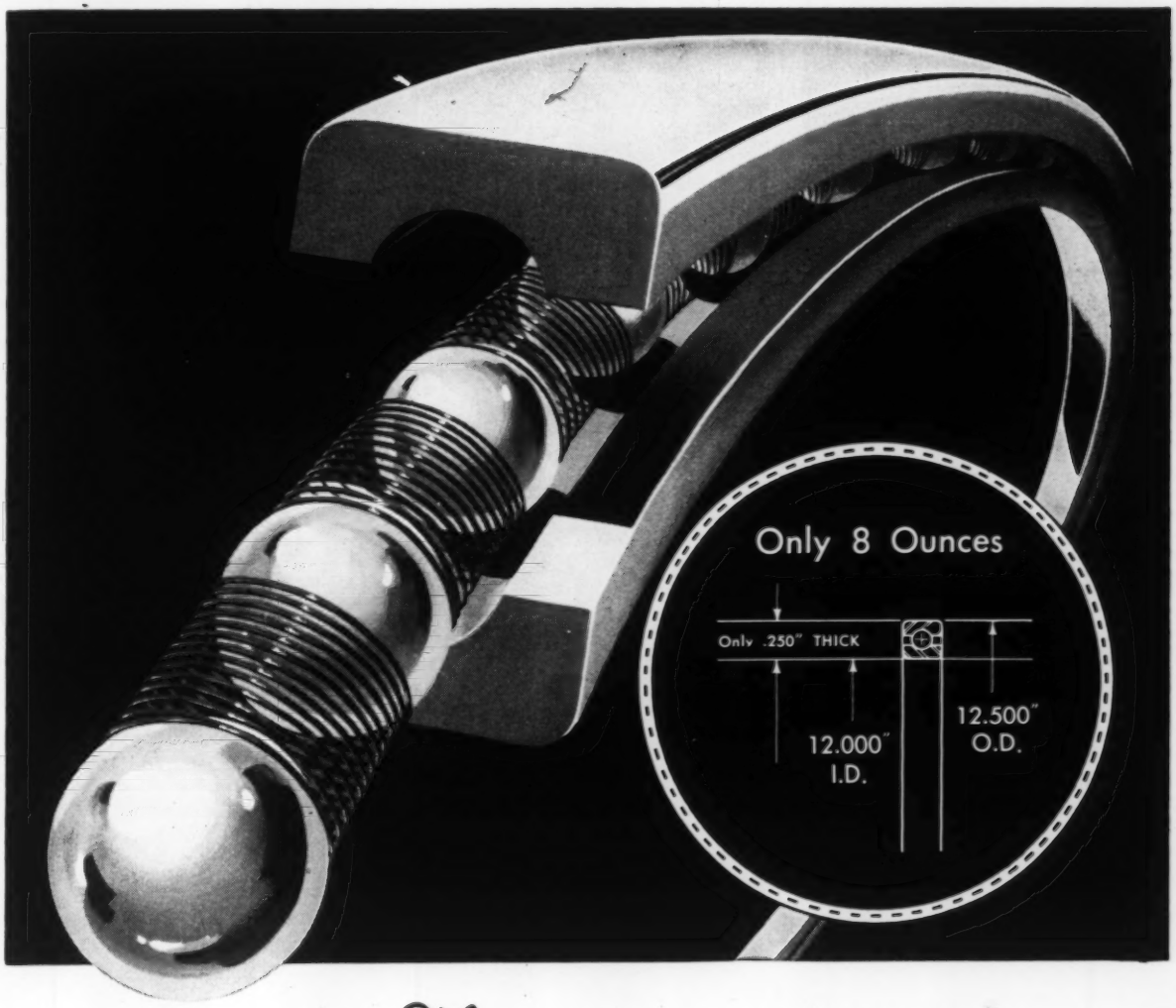


Reali-Slim... by Kaydon
world's thinnest radial ball bearing

HERE'S a typical example of Kaydon's *Reali-Slim* unique radial ball bearing that's finding wide application in practically every industry. *Reali-Slim* are the world's finest thin-section bearings and proportionately are thinner than a wedding ring. The bearing illustrated here is 12.000" I.D., 12.500" O.D., .250" thick — weighs less than 8 ounces. Designed for minimum weight and space limitations, it has a static load capacity of 5,520 lbs. and 894 lbs. at 100 rpm.

If you're looking for *Reali-Slim*, lightweight, radial ball or roller bearings, look at Kaydon's *Reali-Slim* line. Besides hundreds of standard *Reali-Slim* designs, there's a wide variety of special races, seals and separators to meet special bearing problems. What's more Kaydon is able to produce these *Reali-Slim*, high-precision bearings because Kaydon specializes in the unusual. In addition, Kaydon bearing engineers are prepared to give you valuable help with technical bearing application problems.

For complete data on *Reali-Slim* bearings for standard or special applications, ask for engineering Catalog No.54RS-2.

***Reali-Slim* Ball Bearings** — in Conrad, angular contact, 4-point contact and other types are available in seven standard cross sections from .250" to 1" and in bore diameters from 4" to 40".

***Reali-Slim* Roller Bearings** — in radial or taper roller types are available in cross sections from 5/16" and in bore diameters from 5" to 40".

K-554

THE KAYDON ENGINEERING CORP.

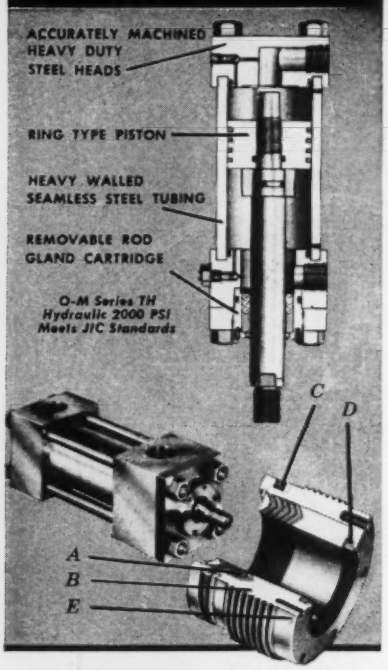
MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" bore to 120" outside diameter . . .

Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Ball Radial • Ball Thrust Bearings

—ITEM 513—

New O-M High Pressure Hydraulic Cylinder equipped with Removable Rod Gland Cartridge



The O-M-engineered removable Rod Gland Cartridge is constructed with a heavy wall steel shell threaded for quick, easy removal, and accurately piloted in rod head to assure perfect alignment. In most applications cartridge can be removed easily without removing mounts or the rod nuts. You simply loosen and remove with a spanner wrench.

A *Rod Packing* — Vee type, non-adjustable, self-compensating, rod gland packing provides multiple lip seal with excellent pressure sensitivity and long life.

B *Rod Bearing* — Extra long, bronze rod bearing provides large bearing surface located well forward for maximum support of piston rod.

C *Cartridge "O" Ring Seal* — With leather back-up washer provides positive seal and acts as friction lock to retain cartridge.

D *Rod Wiper* — Homogeneous lip type located well forward to prevent accumulation of dirt in pocket. Metallic scraper (AN approved) available and interchangeable with wiper.

E *Pilot* — O.D. of cartridge serves as pilot for cylinders mounted on rod end.

O-M Series TH High Pressure Hydraulic (oil) Cylinders — conservatively rated at 2000 P.S.I. — are available in bore sizes 1½ to 8-inch inclusive. Descriptive drawings of cylinder, mounts, mounting brackets and capacity chart are included in the new O-M Bulletin 105. Mail coupon for your FREE copy today.

ORTMAN-MILLER MACHINE CO.
7 143rd Street, Hammond, Ind.

☐ Have representative call ☐ Send Bulletin 105

Name_____ Position____

Company_____

Address_____

City_____ Zone____ State____

—ITEM 514—

Engineering News Roundup

SOUND SLICER, designed by Raytheon Mfg. Corp. for the Army Signal Corps, cuts 21 crystals simultaneously from a solid block of quartz. The cutter vibrates 25,000 times per second and looks like stacked razor blades. Boron carbide flows between the cutter and the quartz. The wafers are 0.012-in. thick, and 2250 can be produced from 12 lb of crystal.

(*Continued from Page* 15)

manufacturing building has a minimum 20-ft clearance from floor to truss.

Stretching through the north half of the manufacturing building for almost the entire length—800 feet—are the two assembly lines on which Caterpillar machines will move into final assembly. On one of the lines, three models of motor graders are assembled. Wheel-type tractors are assembled on the second line. From

It Never Fails . . .

"Sam, we need a bracket for a relay switch. You know the problem and I'd like you to design it. Use your own judgment. Do whatever you think best."

"Well, let's see now. First of all you'd better change the title from Bracket to Support. And I think we'd better up the gage to .064. The material should be 75ST-6. Chamfer the flanges. TA rivets instead of AD and run another stress check."

MILL TESTED AND PROVED

THE FIRST LINT-PROOF TEXTILE MOTOR

- ELIMINATES MOTOR CLEANING COSTS
- SAVES SPACE—PERMITS UNDER FRAME MOUNTING
- TOTALLY-ENCLOSED—PREVENTS WATER DAMAGE
- REDUCES FIRE HAZARD
- FLEXIBLE DESIGN—ADAPTABLE TO ALL MACHINES

Now available—1-20 hp. general-purpose, totally-enclosed, air-cooled, textile motor for application on spinning, roving (low torque), drawing and twisting frames, and on cards, openers, pickers and other textile machines. B-1004

RELIANCE Totally-Protected MOTORS

RELIANCE ELECTRIC AND ENGINEERING CO.

Cleveland 10, Ohio • Offices in Principal Cities

Canadian Division: Welland, Ontario

—ITEM 515—

For More Information Circle Item Number on Yellow Card—page 19

Westinghouse pilot plant for precision castings speeds development, saves capital investment

Incubator for casting ideas

To help you prove your precision casting ideas and developments under production conditions, Westinghouse invites you to use its new pilot plant facilities at Blairsville, Pa. Thus you can speed your metals programs without heavy capital investment.

Westinghouse will also assist you in creating prototype quantities . . . or give you fast, dependable delivery on production quantities of precision investment castings (lost wax process), shell-mold castings and powder metal parts.

Consider molded metal parts for your product components requiring intricate shapes, close tolerances, difficult machining operations or component assemblies. Westinghouse has skilled metals engineers with broad experience to help show you the way to improved products, lower costs.

Send today for further details and a copy of DB 52-500. Also enclose a photo, drawing or sample of the part you want evaluated. No obligation. Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-05002

WATCH WESTINGHOUSE!

*WHERE **BIG** THINGS ARE HAPPENING **TODAY!***

the assembly lines, the machines move onto the final adjustment floor, then to the paint booth.

Significant about the new plant is the speed with which it was built. Ground was broken on February 22, 1954. The first motor grader rolled off its assembly lines June 6, 1955, and the first wheel tractor, October 21, 1955.

Meetings

AND EXPOSITIONS

Aug. 6-8—

Society of Automotive Engineers Inc. National West Coast Meeting to be held at the Mark Hopkins Hotel, San Francisco. Additional information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Aug. 15-17—

Institute of the Aeronautical Sciences. Turbine - Powered Air Transportation Meeting, to be held at the Grant Hotel, San Diego, Calif. Further information can be obtained from institute headquarters, 2 E. 64th St., New York 21, N. Y.

Aug. 21-24—

Western Electronic Show and Convention. Show headquarters, Pan Pacific Auditorium; Convention headquarters, the Ambassador Hotel, Los Angeles. Cosponsored by the West Coast Electronic Manufacturers' Association and the Los Angeles and San Francisco sections representing the Seventh Region of the Institute of Radio Engineers. Additional information can be obtained from Wescon, 344 N. La Brea Ave., Los Angeles 36, Calif.

Sept. 7-9—

Metal Powder Association. Fall Meeting to be held at the Homestead, Hot Springs, Va. Additional information can be obtained from association headquarters, 420 Lexington Ave., New York 17, N. Y.

—ITEM 516—
For More Information Circle Item Number on Yellow Card—page 19

News Roundup

Sept. 10-12—

American Society of Mechanical Engineers. Fall Meeting to be held at the Cosmopolitan Hotel, Denver. Additional information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 10-13—

Society of Automotive Engineers. National Tractor Meeting and Production Forum to be held at Hotel Schroeder, Milwaukee. Additional information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 11-13—

American Die Casting Institute. Annual Meeting to be held at the Edgewater Beach Hotel, Chicago. Further information can be obtained from institute headquarters, 366 Madison Ave., New York 17, N. Y.

Sept. 11-14—

Packaging Machinery Manufacturers Institute. Packaging Machinery and Materials Exposition to be held at the Public Auditorium, Cleveland. Additional information can be obtained from Hanson & Shea Inc., 1 Gateway Center, Pittsburgh 22, Pa.

Sept. 12-14—

Porcelain Enamel Institute. Annual Meeting to be held at the Broadmoor Hotel, Colorado Springs, Colo. Additional information can be obtained from institute headquarters, 1145 19th St. N. W., Washington 6, D. C.

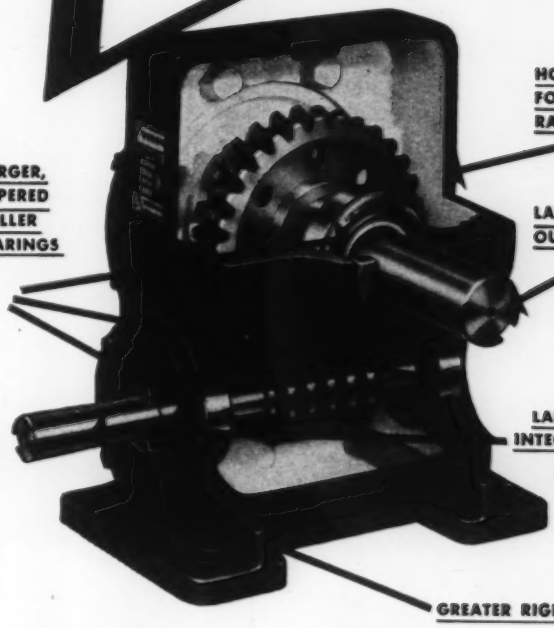
Sept. 16-22—

American Society for Testing Materials. Second Pacific Area National Meeting and Apparatus Exhibit to be held at Hotel Statler, Los Angeles. Additional information can be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa.

Sept. 17-21—

American Society of Mechanical Engineers. Instruments and Regulators Division and Instrument Society of America Exhibit and Joint

7 CHECK POINTS of Speed Reducer Design


HOUSING DESIGNED FOR GREATER HEAT RADIATING CAPACITY
LARGER, TAPERED ROLLER BEARINGS
LARGER, STRONGER OUTPUT SHAFTS
LARGER STRONGER, INTEGRAL WORM SHAFTS
GREATER RIGIDITY

...on the New "C" WINSMITH C SERIES

THESE 5 IMPROVED FEATURES of Winsmith's new "C" Series reducers mean greater performance, greater stamina, greater dependability...*greater value for your horsepower dollar.*

In all, 108 models comprised of single and double reduction units are available in the "C" Series...a unit to answer every speed reducer need. Compare our *increased* rated horsepower and torque output with reducers of competitive makes. For complete data on the "C" Series, write for catalog.

WINSMITH SPEED REDUCERS

NEW CATALOG! Describes the complete "C" Series plus other units in the Winsmith line. Contains drawings, dimensions, weights and ratings for each model described. Write today for Catalog No. 155—on company letterhead, please.

WINSMITH, INC. 16 Elton St., Springville, (Erie County), N. Y.

—ITEM 517—

NEW GEROTOR PUMP-MOTOR

The new Gerotor MB-PMB1.5 Pump-Motor opens wider horizons to the hydraulic designer. Usable as either a pump or a motor, this compact power-package delivers a combination of features previously not found in standard designs.

- 2000 P.S.I.—5000 R.P.M.
- 115% Starting Torque
- 10—1 Speed Range, at
- Constant Torque
- Reversability
- Up to 3.4 H.P.
- High Efficiency, at
- Low Operating Cost.

Consult your nearest Gerotor distributor. Free literature available . . . *write:*

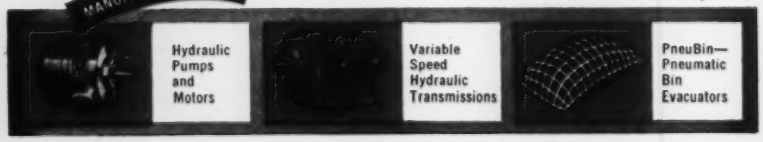
Progress Through Fluid Power by—

GEROTOR

MAY CORPORATION

MANUFACTURERS OF—

1537 MARYLAND AVENUE, BALTIMORE 3, MARYLAND



—ITEM 518—
For More Information Circle Item Number on Yellow Card—page 19

News Roundup

Conference, to be held at the Coliseum, New York. Additional information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 17-21—

Instrument Society of America. Eleventh Annual International Instrument - Automation Conference and Exhibit, to be held at the Coliseum, New York. Additional information can be obtained from society headquarters, 1319 Allegheny Ave., Pittsburgh 33, Pa.

Sept. 17-21—

Illuminating Engineering Society. National Technical Conference to be held at Hotel Statler, Boston. Further information can be obtained from society headquarters, 51 Madison Ave., New York 19, N. Y.

Sept. 23-26—

American Society of Mechanical Engineers. Petroleum - Mechanical Engineering Conference to be held at the Conrad Hilton Hotel, Dallas, Tex. Further information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Sept. 24-25—

Steel Founders' Society of America. Fall Meeting to be held at the Greenbrier, White Sulphur Springs, W. Va. Additional information can be obtained from society headquarters, 606 Terminal Tower, Cleveland 13, O.

Sept. 24-25—

Material Handling Institute. Fall Meeting, to be held at the Greenbrier, White Sulphur Springs, W. Va. Further information can be obtained from institute headquarters, 1 Gateway Center, Pittsburgh 22, Pa.

Sept. 24-28—

Trade Fair of the Atomic Industry to be held at the Navy Pier, Chicago. Additional information can be obtained from Atomic Industrial Forum, 260 Madison Ave., New York 16, N. Y.

MEN

OF MACHINES

R. H. Isbrandt has been appointed director of engineering by American Motors Corp., Detroit. Mr. Isbrandt was named executive engineer early this year. He had

R. H. Isbrandt

been chief design engineer for the company's automotive division since 1953. He was previously associated with Firestone Tire and Rubber Co., Firestone Aircraft Co., and Kaiser-Frazer Corp., and was a chassis designer for Nash Motors from 1929 to 1936.

Osborn Mfg. Co., Cleveland, has announced the election of **R. O. Peterson** to vice president of Brush Div. engineering. He will assume increased responsibility in the company's program of research and development on power brushing methods and brushing machines. Mr. Peterson joined Osborn in 1936 as manager of its technical department.

H. N. Muller Jr. has been appointed chief engineer of the Canadian Westinghouse Co. Ltd., Hamilton, Ont. Mr. Muller joined the Westinghouse graduate student training program in Pittsburgh in

Our customer* needed a variable speed device to power a conveyor "assembly and test stand" which would accommodate metal conveyors up to 18 feet in width and up to 100 feet long. The Gerotor Variable Speed Hydraulic Transmission was the drive selected because it has a:

1. *wide enough speed range*
2. *smooth enough power flow*
3. *built-in overload protection*
4. *compact size, and*
5. *low maintenance factor.*

The installation engineered by Gerotor allows the operator to run the conveyor at speeds *from a smooth creep condition of 6 inches per minute to 120 feet per minute.* The added versatility of being able to adjust the torque output at any speed was theirs at NO EXTRA COST, and the conveyor can be stopped or reversed by means of the Gerotor Transmission.

If you have a hydraulic transmission problem . . . bring it to Gerotor. Free literature available . . . *write:*

*name on request.

Progress Through Fluid Power by—

GEROTOR

MAY CORPORATION

1537 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

MANUFACTURERS OF—

Hydraulic Pumps and Motors

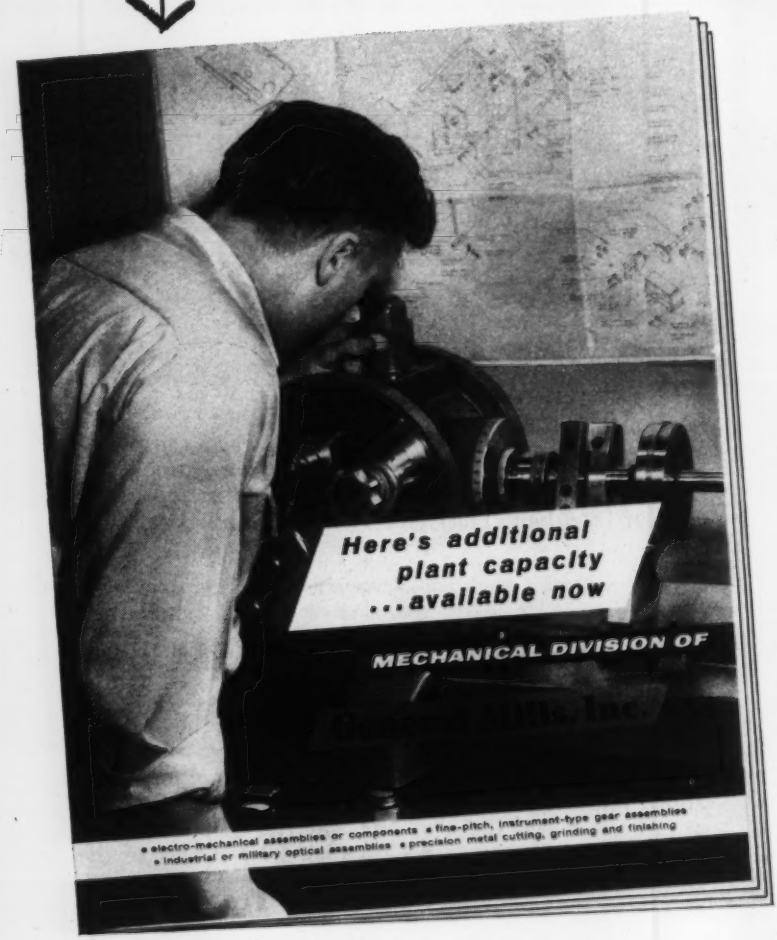
Variable Speed Hydraulic Transmissions

PneuBin—Pneumatic Bin Evacuators

—ITEM 519—

Free booklet tells how to...

Add our brains and machines to those you have now...


Here's additional plant capacity ...available now
MECHANICAL DIVISION OF
• electro-mechanical assemblies or components • fine-pitch, instrument-type gear assemblies
• industrial or military optical assemblies • precision metal cutting, grinding and finishing

You can avoid the pitfalls and problems of plant expansion, yet increase production and cut costs, by putting our experience, equipment and varied skills to work for you. We're equipped to handle the most complex jobs from drawing board stage to final environmental testing. New free booklet describes our facilities, shows our products, names our customers. Write for yours today.

MECHANICAL DIVISION OF General Mills

Dept. MD7, 1620 Central Avenue, Minneapolis 13, Minn.

—ITEM 520—

For More Information Circle Item Number on Yellow Card—page 19

Men of Machines

1935. Since then he has served successively as manager of the graduate student training program, manager of the educational department, assistant to the vice president in charge of engineering and research, and assistant to the vice president for apparatus products.

Concord Control Inc., Cambridge, Mass., has been formed for the purpose of developing and manufacturing numerical control equipment for machine tools and industrial processes. **James O. McDonough** has been elected president, and **Herbert P. Grossimon** is vice president in charge of engineering. Mr. McDonough has been project engineer for the numerical control projects at the M.I.T. Servomechanisms Laboratory since 1951.

Hobart H. Hartong has been named chief engineer of the Joliet, Ill., plant of Phillips Control Corp. He joined the engineering department of this Thor Corp. subsidiary in 1950.

Fafnir Bearing Co., New Britain, Conn., has appointed **Francis G. Patterson** assistant chief engineer in charge of research and **A. Burton Jones Jr.** assistant chief engineer in charge of special projects.

Joseph L. Hussey will head a new analog computer department at Berkeley Div. of Beckman Instruments Inc., Richmond, Calif. Formerly assistant chief engineer for computers, Mr. Hussey has been associated with Beckman for almost four years. His former research and development duties will be assumed by **Alan MacLane.**

Mervin S. Coover, associate dean of engineering and professor of electrical engineering at Iowa State College, was elected president of the American Institute of Electrical Engineers for 1953—1957.

The New York Air Brake Co., New York, has appointed **Karl W. Galliger** director of engineering. Mr. Galliger will be responsible for company research and engineering and for organization policies, pro-

Karl W. Galliger

cedures and development programs of the engineering departments of all divisions. He joined the company in Chicago in 1941 and has been engineering manager of the Watertown Div. since December, 1953.

Charles R. Burrows recently joined Ford Instrument Co., division of Sperry Rand Corp., New York, as vice president for engineering. He will be in charge of all engineering, development and research activities. Dr. Burrows was formerly director of Cornell University's School of Electrical Engineering.

Paul Wildi has been appointed consulting engineer by the Pacific Switchgear Div. of Federal Pacific Electric Co., San Francisco. He was formerly chief engineer of the Pacific Oerlikon Co.

The Harrison, N. J. division of Worthington Corp. has announced several promotions in the engineering department. **E. C. Schmachtenberg,** formerly assistant to the manager of engineering and chief engineer, compressors, has been named assistant to the manager of engineering. **Hunt Davis,** formerly chief engineer, compressor development, has been appointed chief engineer, compressors. **C. A. Macaluso,** previously assistant

New

PLAN-GEAR TRANSMISSION

as simple to operate as an Electric Motor

• Here is AMERICAN GEAR'S new **PGT** transmission as used with a Chrysler engine to power a gasoline tractor. This new, hydraulically operated compound planetary transmission has been successfully used on earth movers, road rollers, tractor loaders and other equipment.

• Complete performance tests at one of the country's leading Institutes of Technology have verified **PGT's** outstanding performance. The report on these tests describes **PGT** as "offering a simple, versatile and extremely flexible means of power transmission...good efficiency ...conservatively rated."*

• **PGT** offers these important advantages over more complex transmissions...

- Easily operated by anyone by merely moving a single hydraulic control lever
- Practically instantaneous (1.5 seconds) change of speed or direction without shifting gears
- Only one control valve lever for all speeds and neutral
- Utterly smooth...no shock...no jerk... no noise
- Cushion shift prevents shock loading, eliminates trouble
- Eliminates operator fatigue by eliminating clutch pedal
- Hydraulic control lever placed convenient to operator without regard to location of transmission
- Planetary gearing means considerably less length for comparable loads and speeds
- Positive pressure-fed lubrication to bearings and gears
- Two power take-off apertures can transmit up to one-third of engine output maximum

*Complete report on request

Write today for this new 8-page booklet which gives complete information, design details on all 7 models of PGT transmissions

7 DIFFERENT MODELS • 85 OR 150 TO 200 LB. FT. TORQUE
1 OR 2 SPEEDS FORWARD • CHOICE OF REVERSE RATIOS

USE PGT TRANSMISSION ON

Lift trucks • Earth movers • Hoists and cranes • Car pullers • Slushers
Conveyors • Power take-offs • Front end loaders • Road rollers
Other industrial equipment • Truck mixers

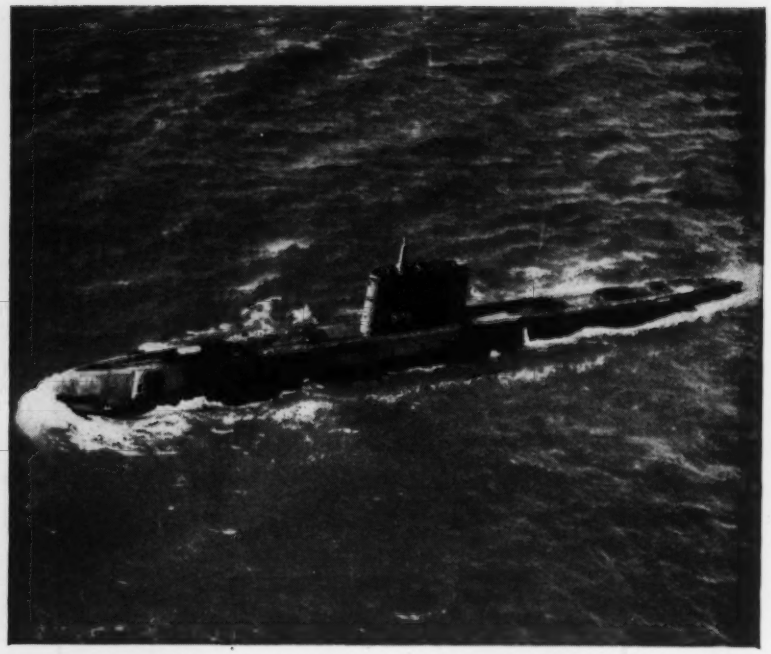
Designed and built exclusively by

AMERICAN GEAR & MFG. CO.

New Avenue, Lemont, Illinois • Phone: Lemont 920

Subsidiary of BRAD FOOTE GEAR WORKS, INC., Cicero 50, Illinois

—ITEM 521—

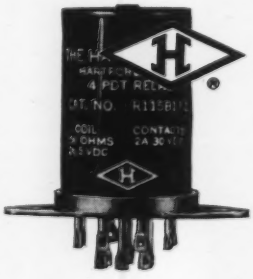


Official U. S. Navy Photograph

'Diamond H' Aircraft-type Relays Go to Sea in the Nautilus

Their reliability proven in such critical land and air applications as guided missiles, jet engine controls and fire control systems, "Diamond H" miniature, hermetically-sealed, aircraft-type relays were chosen by Westinghouse for an important role in the world's first atomic-powered submarine. They're used in the reactor control system of the Nautilus.

Possible performance characteristics of "Diamond H" Series R 4 PDT relays span such broad ranges that the modifications which can be arranged to meet particular sets of requirements are almost endless. They're fully described in Bulletin R250, a copy of which is yours for the asking. Our engineers will gladly work with you to develop a variation for your specific need.



THE HART MANUFACTURING COMPANY

118 Bartholomew Avenue, Hartford 1, Conn.

—ITEM 522—

For More Information Circle Item Number on Yellow Card—page 19

Men of Machines

manager, research and development, has been named assistant chief engineer, compressors. **W. F. Donovan,** formerly group supervisor, research and development, has been appointed assistant manager, research and development.

Herbert S. Bennett has joined the engineering staff of Allen B. du Mont Laboratories Inc., Clifton, N. J. as a technical specialist in the military electronics field. Dr. Bennett was formerly director of research and development at Dynamic Electronics Corp.

David J. Munroe has been named president of the Webster Electric Co., Racine, Wis. He has been chief engineer of the company for 14 years.

Bell Aircraft Corp., Buffalo, has promoted **Lester K. Fero** to assistant chief of preliminary design. He is succeeded as chief of structures by **Arthur Schnitt,** formerly assistant chief of the department. **Robert Goldin** is now assistant chief of structures.

Robert S. Butts has been appointed chief engineer of Melpar Inc., Falls Church, Va. Mr. Butts joined the firm in 1947 as a senior engineer.

Kaydon Engineering Corp., Muskegon, Mich., has appointed **Angelo J. Perna** director of engineering. Mr. Perna has been head of structural research and development at Pullman Standard Car Co. Previous affiliations include assignments as chief structures engineer for Duramold Div. of Fairchild Engine and Airplane Corp., and stress and development engineer for Republic Aviation.

George A. Hawkins, dean of engineering, Purdue University; **Milton J. Thompson,** professor of aeronautical engineering and associate director, Defense Research Laboratory, University of Texas; and **Ford Lee Wilkinson, Jr.,** president of Rose Polytechnic Institute, have been named Fellows by the American Society of Mechanical Engineers.

Men of Machines

Erco Div., ACF Industries Inc., Riverdale, Md., has announced the appointment of **Morris Ackerman** to chief simulator engineer. **Charles B. Smith** succeeds Mr. Ackerman as chief project engineer. **Leonard C. Wright** has been appointed chief group engineer, and **Charles L. Cohen** is now preliminary design group engineer, succeeding Mr. Wright.

Alfred A. Augustine has been named chief engineer of Loftus Engineering Corp., Pittsburgh.

Edward W. Hackney has joined the Herbrand Div. of the Bingham-Herbrand Corp., Fremont, O., as manager of research and development. Mr. Hackney had been associated with the General Electric Co. as a design engineer. Immediately prior to his new appointment he was employed by the Oldsmobile Div. of General Motors as an engineer.

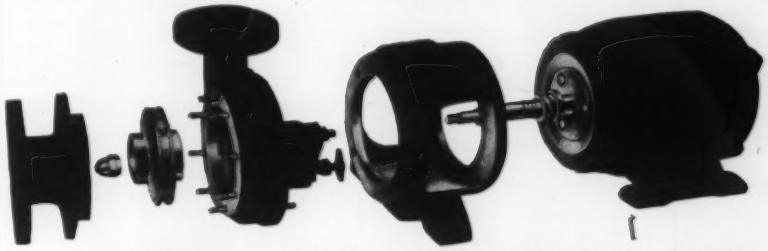
Penn-Union Electric Corp., Erie, Pa., has announced the appointment of **Morris Brenner** as chief engineer. He was formerly associated with Burndy Engineering Co.

W. A. Pulver has been named assistant chief engineer of the Georgia Div. of Lockheed Aircraft Corp. at Marietta. Mr. Pulver joined Lockheed at the California Div. in 1936 as project engineer on the P-38 fighter.

Stanley J. Front has been appointed mechanical engineer by Alto Scientific Co. Inc., Palo Alto, Calif. Mr. Front has served as aircraft and automobile engine designer for Vickers Ltd. and as heavy equipment designer for Northwest Engineering Co. and Skagit Steel & Iron Works. Most recently he was chief development engineer for the Willamette Iron & Steel Co.

Gifford-Wood Co., Hudson, N. Y., has announced the appointment of **Alfred H. Hallenbeck** as a vice president. Mr. Hallenbeck joined the company 35 years ago in the engineering department.

It's designed and built the way you would do it for efficient liquid flow!



Glance at this exploded view of the

INGERSOLL-RAND

MOTORPUMP

Now you have an idea of the clean-cut simplicity of its efficient design. It's the design that gives continuous full-load capacity—the reason I-R Motorpumps have been out in front over the years.

They're compact—valuable space is saved. Durable—low maintenance is assured. And because you can specify Motorpumps which operate in *any* position your design problems are greatly simplified.

Moreover, the Motorpump line is so complete that you can specify anywhere from ¼ hp to a powerful 75 hp size . . . 5 to 2800 gpm . . . by standardizing on I-R!

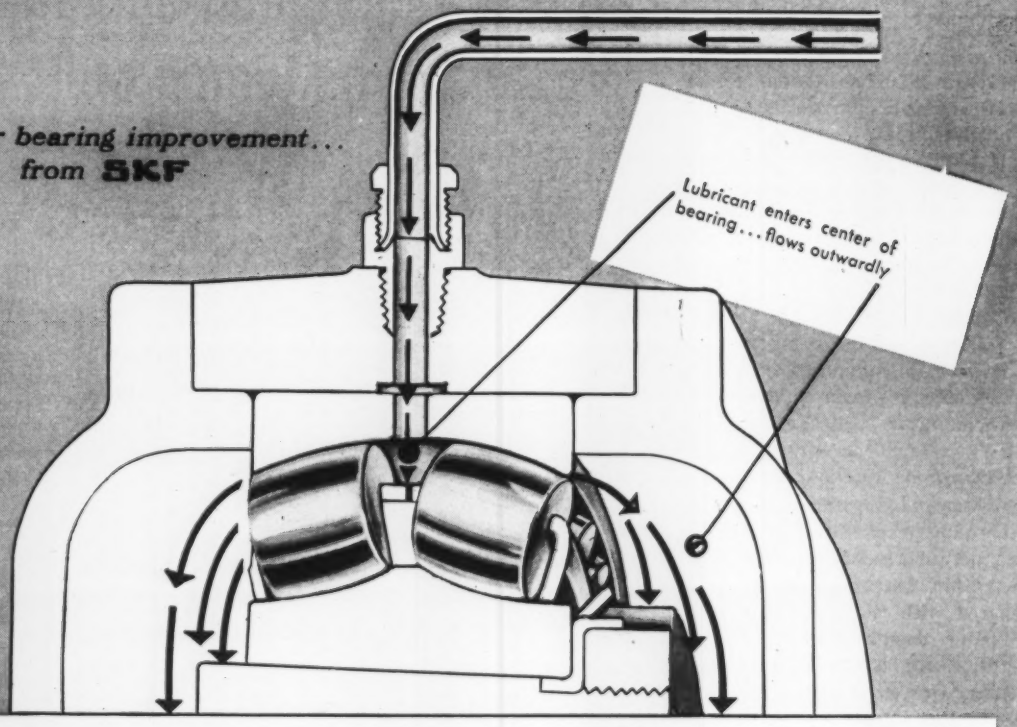
If you are not familiar with the full line of centrifugal, circulating and coolant Motorpumps, we'll be glad to send you our latest catalogs. Write today.

Ingersoll-Rand

9-370 11 Broadway, New York 4, N. Y.

—ITEM 523—

Another bearing improvement... from **SKF**



NOW AT NO EXTRA CHARGE-

SKF's improved method of lubricating large spherical roller bearings

To make the lubricant effective it should be located where needed—in the bearing. Also, new lubricant, when added, should enter where it does the most good—in the bearing.

For these reasons, all future production of SKF double row spherical roller bearings above 240 mm O.D. (9.4488") will be made with three equally spaced drilled holes in the center of the outer ring without any extra charge to our customers. *This permits the lubricant to enter the center of the bearing.*

With the lubricant (either grease or oil) being introduced into the center of the bearing, all working surfaces are quickly and completely covered. In addition, the outward flow flushes out the old lubricant, and with it, any abrasive dust, dirt, moisture or other impurities.

And where circulating oil lubrication is required, there is a continuous flushing and cooling of the bearing.

This is another example of how SKF helps you to obtain longer bearing life.

7711

Consult your SKF District Office today for complete information so that you can be the first to incorporate into your products this improved method of lubricating large spherical roller bearings.

SKF®

BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

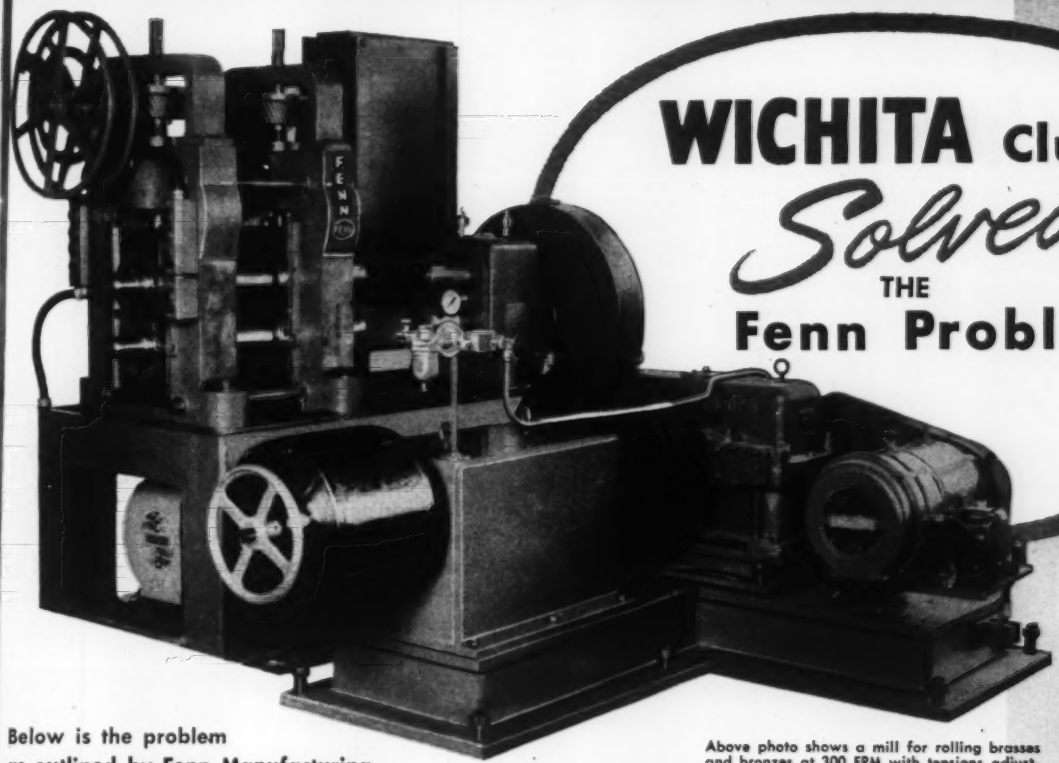
—manufacturers of SKF *and* HESS-BRIGHT® *bearings.*

—ITEM 524—

For More Information Circle Item Number on Yellow Card—page 19

Facing Page—ITEM—525→

WICHITA Clutch Solved THE Fenn Problem!



Above photo shows a mill for rolling brasses and bronzes at 300 FPM with tensions adjustable from 400 to 3,000 pounds.

Below is the problem as outlined by Fenn Manufacturing Company, Newington, Connecticut. They also state how WICHITA Clutches solved their problems.

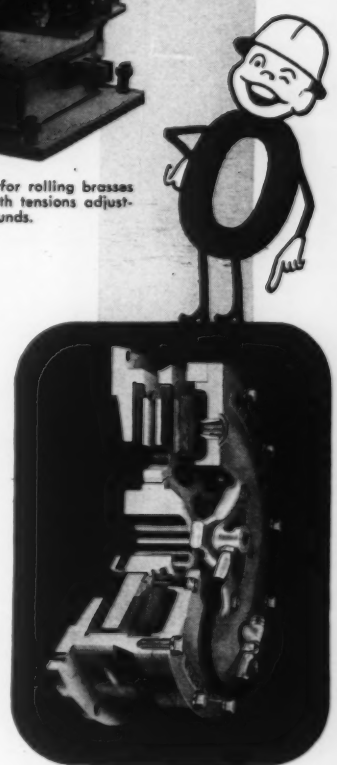
An inexpensive machine for rolling and coiling metal onto a drum. It could be done. But these problems arose:

1. The machine must have a clutch that slips at a high rate of speed since most coils have an increase in diameter of 300% to 600% from start to finish.
2. The clutch must constantly slip throughout the run since it is geared-in to run about 20% faster than the mill at maximum drum speed in order to insure correct tension at all itmes. This means slipping seven hours out of every eight.
3. Tension loads on rolled strip are high, representing high torque capacities at the clutch.
4. Successive passes on the strip require less and less tension, meaning a reset of the clutch torque value for each pass.

The WICHITA Clutch Answer . . .

1. They will take higher rates of slippage without excess wear or damage than any other we have tried.
2. They offer us far greater torque values per inch of diameter as well as per pound of weight.
3. They are readily adjustable as to torque settings by merely reducing air pressure at the regulating valve.
4. They embody the only packless air "cylinder" with air-tight construction, durability, and uniformity of performance.

WICHITA Air-Tube Clutches are solving many problems in plants throughout the world . . . with never a replacement having had to be made!



Important Features

- CONTROLLED TORQUE, IMMEDIATE RESPONSE
- EASIER MAINTENANCE
- EXTREMELY LONG LIFE
- NO LUBRICATION
- POSITIVELY VENTILATED FOR COOLER OPERATION

Consult Your Nearest Wichita Engineer for Complete and Detailed Information

WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

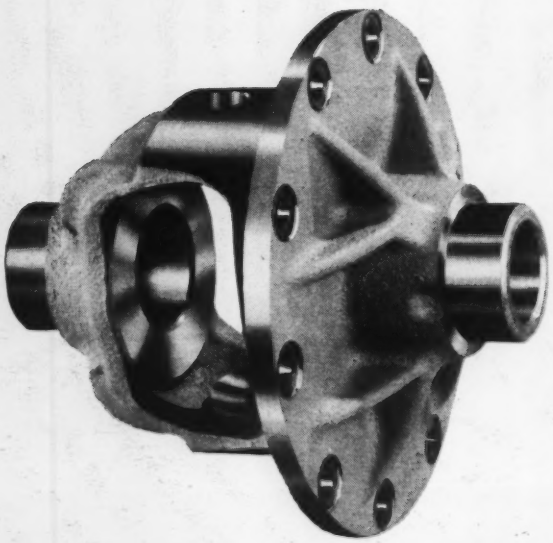
WICHITA DISTRIBUTORS

Brehm-Lahner, Inc., Detroit, Michigan
L. H. Fremont, Cincinnati, Ohio
W. G. Kerr Company, Pittsburgh, Pa.
Smith-Keser & Co. (Main Office), Avon, Conn.
Smith-Keser & Co., Philadelphia 44, Pa.
Smith-Keser & Co., New York, New York
Frank W. Yarline Co., Chicago, Ill.
Power Rig & Equipment Co., Inc., Long Beach, Calif.
Sales Engineering Company, Inc., Salt Lake City 4, Utah
Robert R. King Co., Cleveland, Ohio
John C. Burge, Oklahoma City, Okla.
Dominion Power Press Equipment Ltd., Longacres P. O., Aldershot, Ontario, Canada
Hunt Tool Co., Houston, Texas
Industrial Air Controls Co., Fort Worth, Texas
Allied Transmission Equipment Co., Kansas City 8, Missouri

how ARMASTEEL
wider scope of

NEW PRODUCT DESIGNS POSSIBLE . . . Due to their unusual physical properties, high machinability ratings, and wide latitude of design, ArmaSteel castings are replacing other materials in today's products. Being a casting material, ArmaSteel can be formed in shapes too complex for the forging process. With ArmaSteel castings, low draft angles, intricate coring, and close dimensional tolerances are possible. Less stock remains to be machined. High tensile strength, damping qualities, and other physical and chemical characteristics are also major factors in ArmaSteel's popularity among product design engineers.

ARMASTEEL IS A PEARLITIC MALLEABLE IRON, possessing many of the physical characteristics of forged low-carbon steel. Because of carbon nodules in the pearlite matrix, the machinability of ArmaSteel castings is 58% better than S.A.E. 1040 steel and compares favorably with S.A.E. 1112. ArmaSteel is produced in three ranges, with tensile strengths from 70,000 psi to 100,000 psi, yield strengths from 48,000 psi to 80,000 psi, and elongations (in 2") from 2% to 4%. Because of these excellent properties, and because it can be either sand cast or shell cast, ArmaSteel provides improved parts for many products, at the same time that it lowers costs. On these pages are two case histories of products that have benefited from ArmaSteel castings . . . perhaps your product can benefit too.

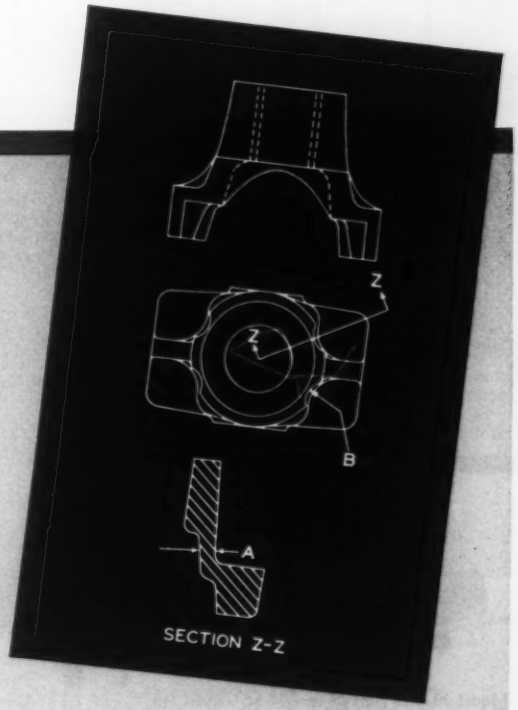


CAST ARMASTEEL IMPROVES AN AUTOMOBILE DIFFERENTIAL CASE

This case forms the support for the driving gears in an automobile. The demands made of such a part are that it be of high strength, that it have the least possible deflection, and that—because it is part of the car's unsprung weight—its weight be held to a minimum to help the riding characteristics. The part must be cast because it is impossible to forge the internal cavity.

ARMASTEEL 86M MET ALL THESE DEMANDS. It has a tensile strength of 70,000 psi, a yield strength of 48,000 psi, and a Brinell Hardness No. of 163-207. Deflection is very low, and ArmaSteel absorbs vibrant energy, thus contributing to quiet operation. The cast ArmaSteel part also allowed the manufacturer to eliminate thrust washers on the pinion gear bearings, reducing costs.

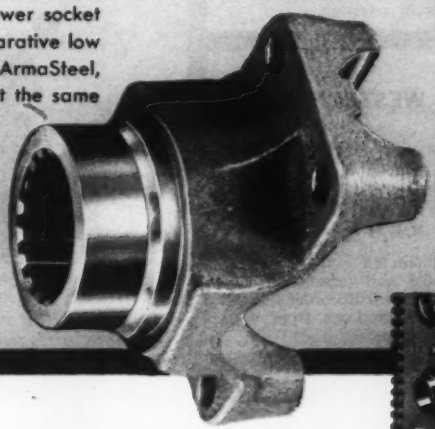
castings allow new and much design



CAST ARMASTEEL REPLACES FORGINGS IN THIS COMPANION FLANGE BECAUSE OF SPACE LIMITATIONS

This part was formerly a medium carbon steel forging. During a re-design of the unit, it was impossible to get the desired strength by enlarging the part, because of design limitations. It became apparent that the draft angles necessary in the forging would not allow proper thickness of metal at point "A". Only a casting could achieve the low draft angles needed, and only a high strength material could meet the design requirements.

CASTINGS OF ARMASTEEL 84M PROVIDED THE ANSWER. ArmaSteel 84M has an ultimate tensile strength of 100,000 psi, and a yield strength of 80,000 psi. ArmaSteel parts tested showed a long fatigue life and minimum deflection under the extreme stress involved. In addition, castings offered a reasonable cost per piece, excellent machinability, and uniformity in production lots. In broaching the spline in the center hole, the manufacturer found that ArmaSteel castings resulted in greatly improved broach life. Draft angles were reduced to 2°, which allowed sufficient clearance (point "B") for the power socket wrench assembly operations. Thus, due to the comparative low cost of castings and the reduced machining costs of ArmaSteel, the manufacturer enjoyed an overall saving and at the same time solved his design and assembly problems.



66

For further information on physical properties and applications of ArmaSteel, write for our complete catalog. Descriptive literature is also available on our shell mold and sand casting processes.

CENTRAL FOUNDRY DIVISION · GENERAL MOTORS CORPORATION

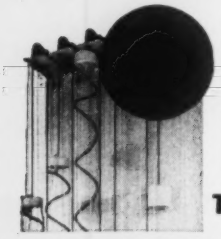
CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN • DEPT. 14

—ITEM 526—

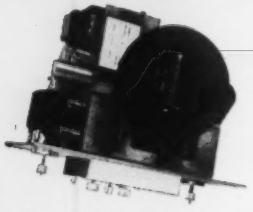
NEWLY DESIGNED

Howard Induction Motor Model 2900 Offers 18% Overall Improved Performance and Efficiency for Critical Applications



MERIAM MULTIPLE TUBE COMMON WELL TYPE MANOMETER

Model 2900 motors with gear units are used to motorize each well, quickly position the datum level required for the pressure range of the test involved.



MAGNECORD TAPE RECORDERS

Model 2900 is used in several MAGNECORD high fidelity professional units. Extremely quiet operation, minimum cogging, minimum mechanical vibration are major points in selection.

WESTERN UNION RECORDER #5616B

Mfd. by J. P. Seeburg Corp.

Model 2900 motors maintain an exactly constant speed, are extremely quiet and dependable. Selected by Western Union for their Recorder #5616B that transmits and receives messages from users office to Western Union office.

MODEL 2900—2 pole, 4 pole, 6 pole, 8 pole, 1, 2, or 3 phase and split phase applications. 1/100 to 1/15 h.p.

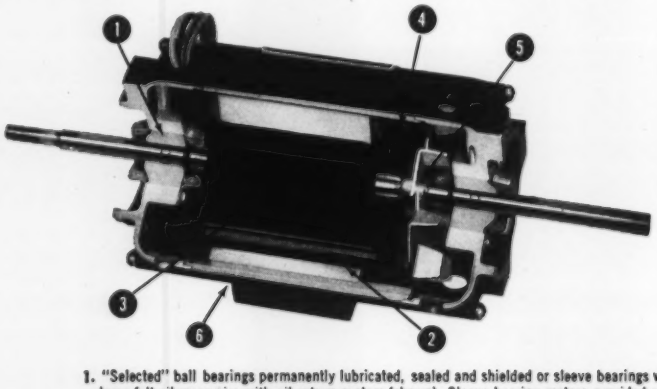
The applications shown above are just three of many applications now served by HOWARD MODEL 2900 motors.

The new HOWARD 2900 motor incorporates completely redesigned magnetic and electric circuits with increased stator and rotor slots, 24/20 slot lamination as against 16/14 slot lamination in the old 2900 design. The advantages are as follows:

- Six pole 2900 motors in Induction, Hysteresis and Torque types are now available. Of particular importance is the new six pole Torque motor which operates with extreme smoothness and practically no detectable variation of stalled torque throughout a rotor revolution. Almost perfect linearity in the speed-torque curve has been achieved at speeds varying from 0-1000 RPM.
- The new Reluctance Synchronous 2900 motor becomes suitable for many critical operations (in particular, tape recorders) where only expensive Hysteresis units were previously conceivable. Reduction of the external field permits the motor to be used without magnetic screening.
- The new 2900 design will permit operation of motor on 3 phase, 60, 180 and 400 cycle, 2/4/6 poles.
- The efficiency and power factor have been improved by an average of 20%. Heat rise is considerably lower which results in: a. Longer Motor Life b. Longer Bearing Life c. Minimum lubrication trouble d. Ability to operate in higher ambients
- There is substantially less mechanical vibration.
- There is less electrical and mechanical noise.

At request all 4 and 6 pole motors can be made reversible in motion.

Prices on the new Howard 2900 motor are moderate. Many gear ratios are available. Write today for complete information on MODEL 2900 and other Howard Induction motors, Series and D. C. motors and Shaded Pole motors. Howard's fractional h.p. motor selector chart is available on request.



1. "Selected" ball bearings permanently lubricated, sealed and shielded or sleeve bearings with large felt oil reservoirs with oil return system (shown). Sleeve bearing motors provided with ball thrust bearing for vertical operation.
2. 24 slot lamination design for quiet, cool operation. Stamped from high grade electrical steel.
3. Rotors dynamically balanced, skewed to give uniform torque characteristics with change of rotor angle.
4. Windings of heavy Formvar insulated wire, impregnated and baked with top grade electrical varnish.
5. Internal fan for cooling. 6. The case is a sturdy rigid casting.

Other Howard motors: UNIVERSAL & D.C. 1/200 to ½ h.p. • SHADED POLE 1/2000 to ⅓ h.p. • INDUCTION 1/1400 to ⅓ h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

DEPT. MD-7 • HOWARD INDUSTRIES, INC. • RACINE, WIS.

SALES OFFICES: 208 S. La Salle St., Chicago 4

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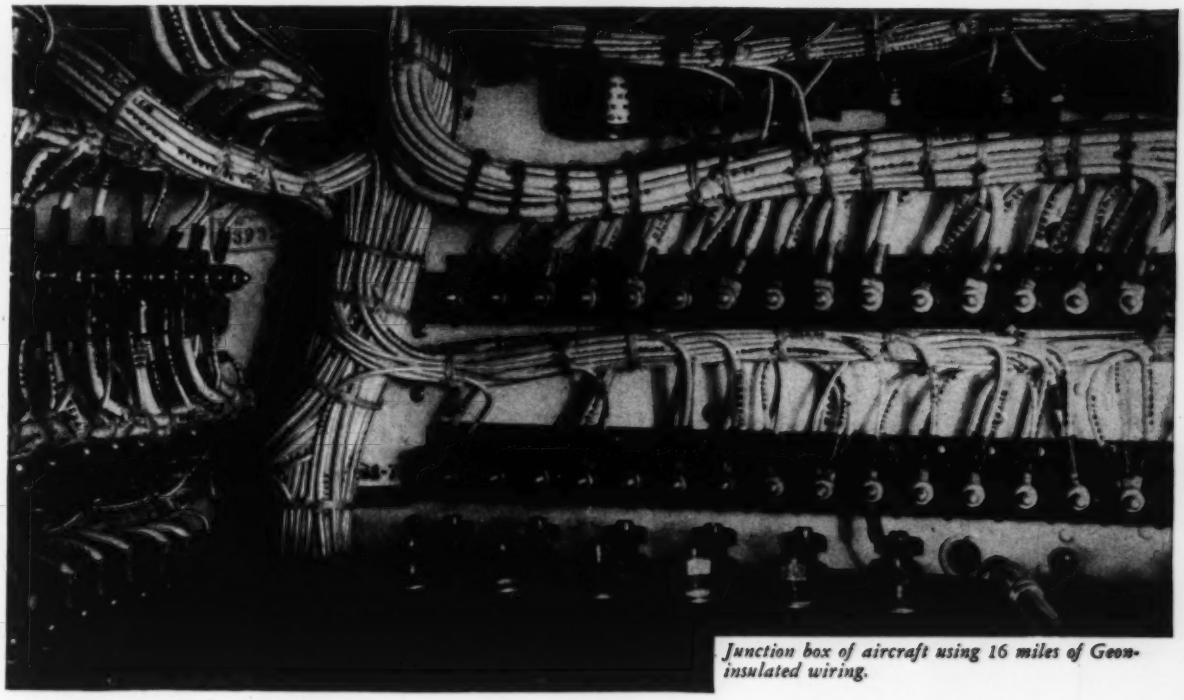
Buy Defense Bonds

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · RACINE ELECTRIC PRODUCTS

—ITEM 527—

News about

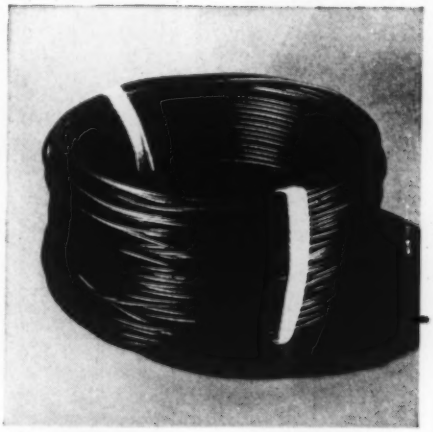
B.F.Goodrich Chemical *raw materials*



Junction box of aircraft using 16 miles of Geon-insulated wiring.

For wiring that shrugs off water, chemicals, flame...

specify Geon insulation



You can select wire and cable with Geon used either as primary insulation, or jacketing, or both. Many compounds available to meet specific requirements.

GEON-INSULATED wire and cable provides *power dependability* despite tough operating conditions.

Take water. Geon insulation tested by continuous immersion in water for three years showed no appreciable change in its excellent electrical properties. Geon has superior resistance to oils, resists most acids at all concentrations under many conditions. Geon compounds are flame resistant.

In physical properties Geon is likewise outstanding. Compounds aged outdoors for up to fifteen years have retained original properties. Geon is tough and abrasion resistant, keeps flexibility at very low temperatures.

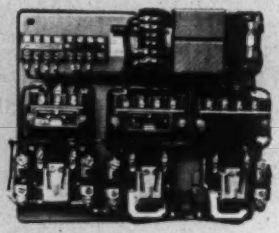
Leading manufacturers offer Geon-insulated wire and cable for automotive and aircraft use, electrical equipment, machine tools, signal systems . . . wherever power dependability is important. For booklet giving complete data on Geon insulation properties, write Dept. DO-4, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

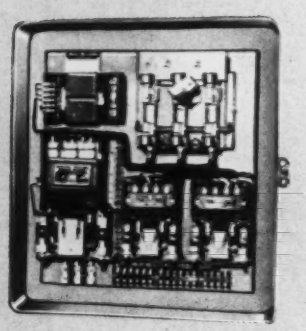
B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

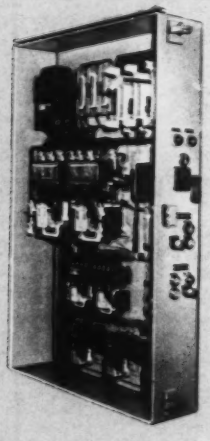
B.F.Goodrich GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

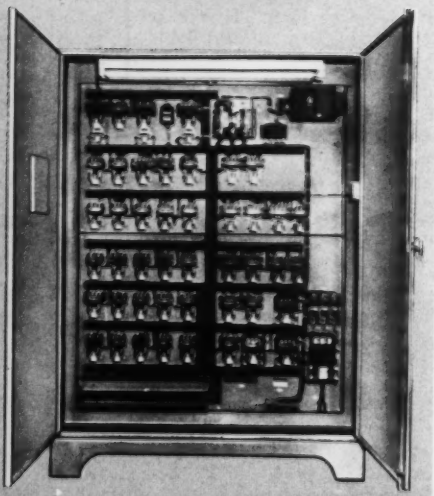
G-E general purpose control on

TYPICAL PANELS









NEW HIGH PRODUCTION GRINDER EQUIPPED WITH G-E CONTROL HOLDS 15 MICROINCH FINISH

This new Van Norman Bowgage Production Grinder is designed for high production grinding of any part that can be readily chucked. The grinder can remove 0.022-inch on a 1⅝-inch diameter piece, hold a 15 microinch finish, and with operator initiated automatic clamping can have a new piece ready for grinding every 15 seconds.

Manufactured by the Van Norman Machine Co., Springfield, Mass., the Bowgage Production Grinder provides the equivalent of two Single Head Production Grinders on a single base. This reduces the floor space required, operator fatigue, handling time, and maintenance.

XUM

machines for industry

4 WAYS TO BENEFIT WITH PAN-A-TROL PANELS

NEW G-E PAN-A-TROL* PANELS

A new program for packaged machine control from General Electric

Pan-A-trol panels are the focal point of a new program from General Electric for packaged machine control. This program, which places a new emphasis on panels for the dynamic automation age, features outstanding service to customers. The Pan-A-trol name distinguishes these panels which are applied to machines with a maximum rating of 200 horsepower, 600 volts, a-c.

This new program emphasizes the General Electric services available to you with Pan-A-trol packaged control. An enlarged engineering staff is ready to work with you on developing a circuit and panel design to meet your machine requirements. These G-E engineers can also help you take advantage of cost reductions due to repetitive or quantity Pan-A-trol orders.

Faster and better factory service is provided by expanded manufacturing facilities. Up-to-date equipment and skilled employees assure you of fast, prompt shipment. And, of course, General Electric's field service organizations assure your customers of fast local service if desired.

PAN-A-TROL NAMEPLATE identifies each panel. Built from your specifications, these panels offer you the installation, maintenance, and reduced stocking benefits of packaged control.

See your G-E Apparatus Salesman about this new program, and let him tell you how you can benefit from Pan-A-trol packaged control. **And, write Section 731-3 for bulletin GEA-6334.** General Purpose Control Department, General Electric Company, Bloomington, Illinois.

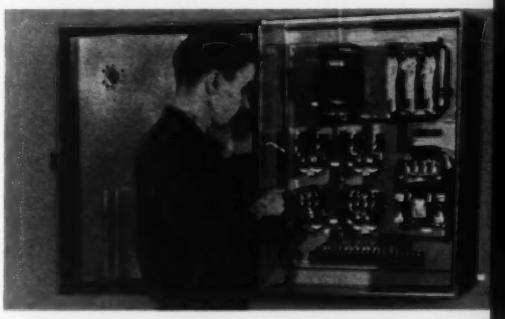
*Reg. trade-name of General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC

ENGINEERING ASSISTANCE. An enlarged staff of General Electric engineers in the factory and local offices are ready to help you with Pan-A-trol panels for specific applications.

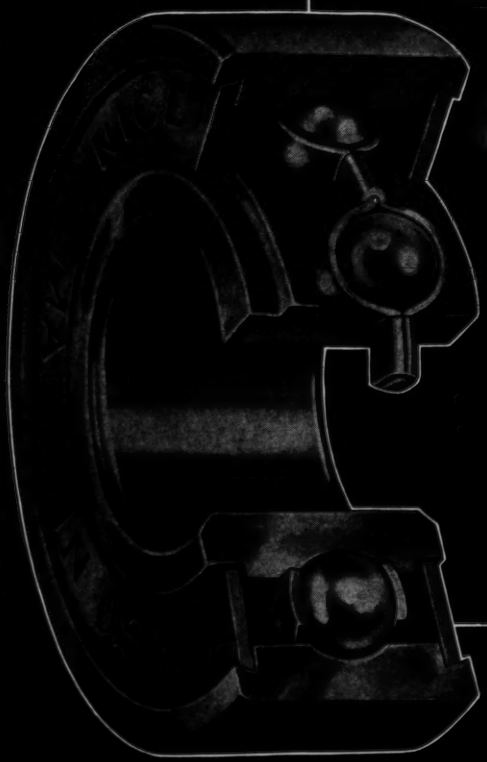
MANUFACTURING FACILITIES. Skilled employees in new, enlarged factory facilities with the latest manufacturing methods assure fast, prompt shipment for Pan-A-trol control panels.



UNIT DESIGN. Pan-A-trol packaged control combines circuit design, device selection and arrangement into one coordinated unit. Only connections to rest of machine need be made.

PAN-A-TROL QUALITY. High-quality components and construction, backed by General Electric's field services, assure long dependable performance with Pan-A-trol packaged control.

Have you given NICE a chance to Quote?



STANDARD and SPECIAL BALL BEARINGS Since 1902

WRITE FOR CATALOG NO. 150

NICE

NICE BALL BEARING COMPANY
NICETOWN · PHILADELPHIA · PENNSYLVANIA

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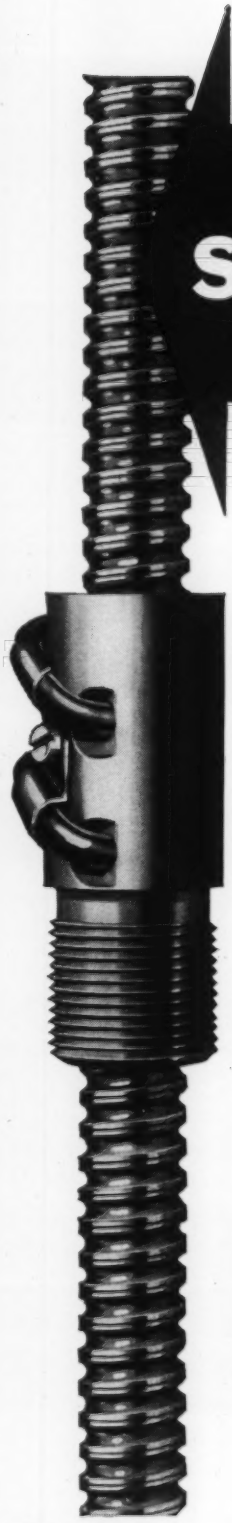
High efficiency—low cost



STANDARD-SIZED ROLLED-THREAD SAGINAW b/b SCREWS

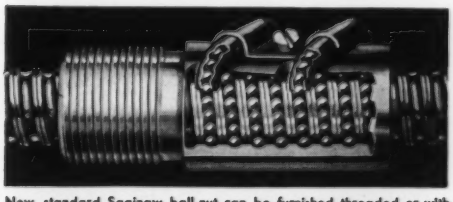
Provide 4 times more efficiency than conventional screws—and require only 1/4 of the power. Reduce size, weight, cost of entire unit.

Here's great news for every manufacturer who uses Acme screws or hydraulic actuators in his product! Saginaw now offers Rolled-Thread *Saginaw b/b Screws* in standard sizes at amazingly low mass-production cost.

In many applications this new rolled-thread type will provide completely adequate performance at a fraction of the cost of machined-thread units.

GIVE YOUR PRODUCTS THESE PERFORMANCE ADVANTAGES AT NO INCREASE IN COST—

- **At least 90% efficiency guaranteed**—compared with 15% to 20% efficiency of Acme screws.
- **Requires less than 1/3 as much torque as** Acme screws for same amount of lineal output.
- **Saves substantially on cost, size and weight** of motors, gear boxes and auxiliary equipment.
- **Far less wear—less maintenance—longer life.**
- **Precision positioning**—free play can be virtually eliminated where necessary.
- **Operates dependably with or without lubrication** at temperatures from −75° F. to +275° F.



New standard Saginaw ball-nut can be furnished threaded or with flange or trunnion-type adaptors for easy application to almost any unit.

ROLLED-THREAD *SAGINAW b/b SCREWS* ARE NOW AVAILABLE IN THESE STANDARD SIZES AND ANY SCREW LENGTH:

Ball Circle Diameter	Ball Size	Lead
.375	.0625	.125
.631	.125	.200
1.000	.15625	.250
1.171	.28125	.41304
1.500	.34375	.47368
2.250	.375	.500
3.000	.500	.660

ROLLED-THREAD *SAGINAW b/b SCREWS* ARE ALREADY BEING SUCCESSFULLY USED IN THESE TYPICAL APPLICATIONS:

- Automatic Garage Doors
- Automobile Seat Adjusters and Window Lifts
- Barber Chairs
- Bumper Jacks
- Circuit Breakers
- Convertible Top Lifts
- Die Table Positioners
- Drill Presses
- Marine Steering Gears
- Welding Machines

--SEND FOR FREE DATA BOOK--

Saginaw Steering Gear Division
Ball Bearing Screw and Spline Operation, Dept. 7H
General Motors Corporation, Saginaw, Michigan

Please send detailed data on your new Rolled-Thread *Saginaw b/b Screws*. I am interested in their application to:

Name—Title_____

Firm_____

Address_____

City_____ Zone____ State_____

SAGINAW STEERING GEAR
DIVISION OF
GENERAL MOTORS
CORPORATION,
SAGINAW, MICHIGAN

Saginaw Ball Bearing **Screws** and **Splines**

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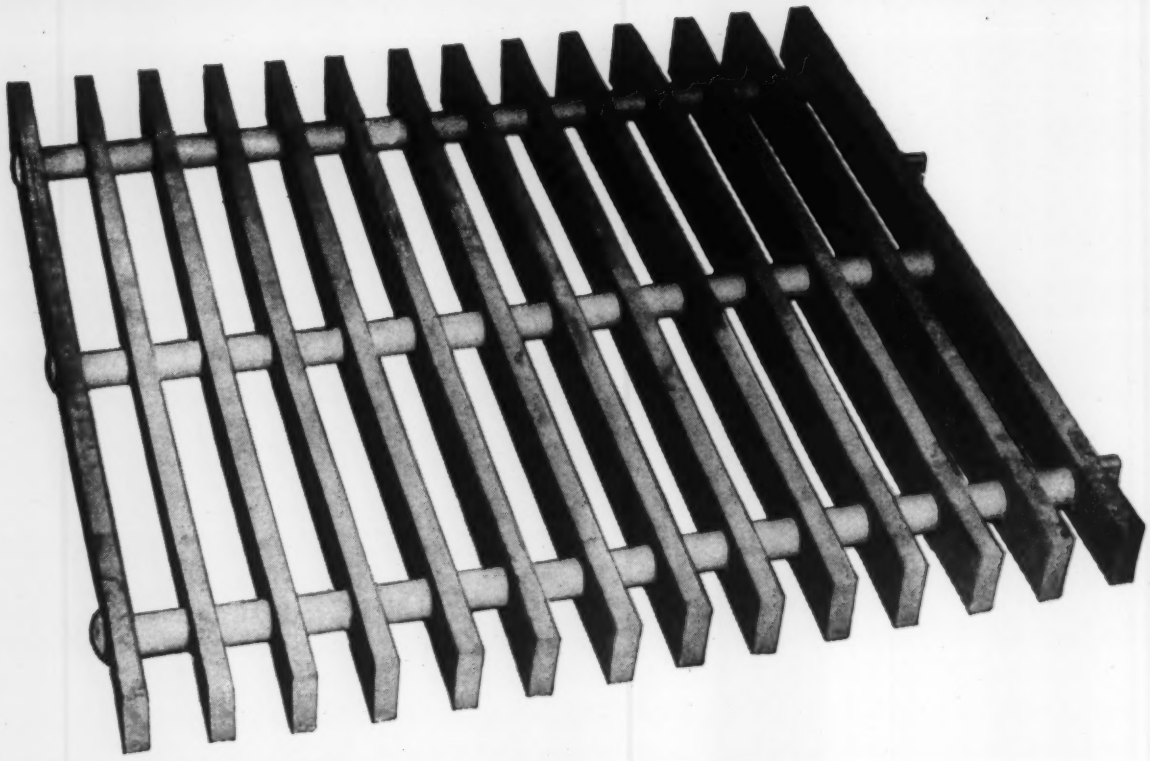

STILL LIKE NEW

. . . After 100 Operations at 2300 deg. F

This tray made of HASTELLOY alloy X has been heated to 2300 deg. F on more than 100 different occasions and still shows no signs of oxidation or distortion. In each cycle the tray is heated to 1300 deg. F for an hour, and then to 2300 deg. F for an additional half hour. Trays made from other materials, and used under the same conditions, failed from oxidation and warpage after a few firing cycles.

The tray is 18 in. square and is fabricated from HASTELLOY alloy X sheared plate. It is used to support heavy molds during a tungsten carbide bonding process.

HASTELLOY alloy X has given similar good service in other furnace applications such as muffles, flame targets, rollers, and heating tubes. It is equally suitable for use in jet engine tailpipes, afterburner components, and other aircraft parts exposed to heat and oxidation.

For complete information on properties and forms, ask for the booklet, "HASTELLOY Alloy X."

HAYNES TRADE-MARK ALLOYS

HAYNES STELLITE COMPANY

A Division of Union Carbide and Carbon Corporation

UCC

General Offices and Works, Kokomo, Indiana

Sales Offices

Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

"Hastelloy" is a registered trade-mark of Union Carbide and Carbon Corporation.

P-54-2706

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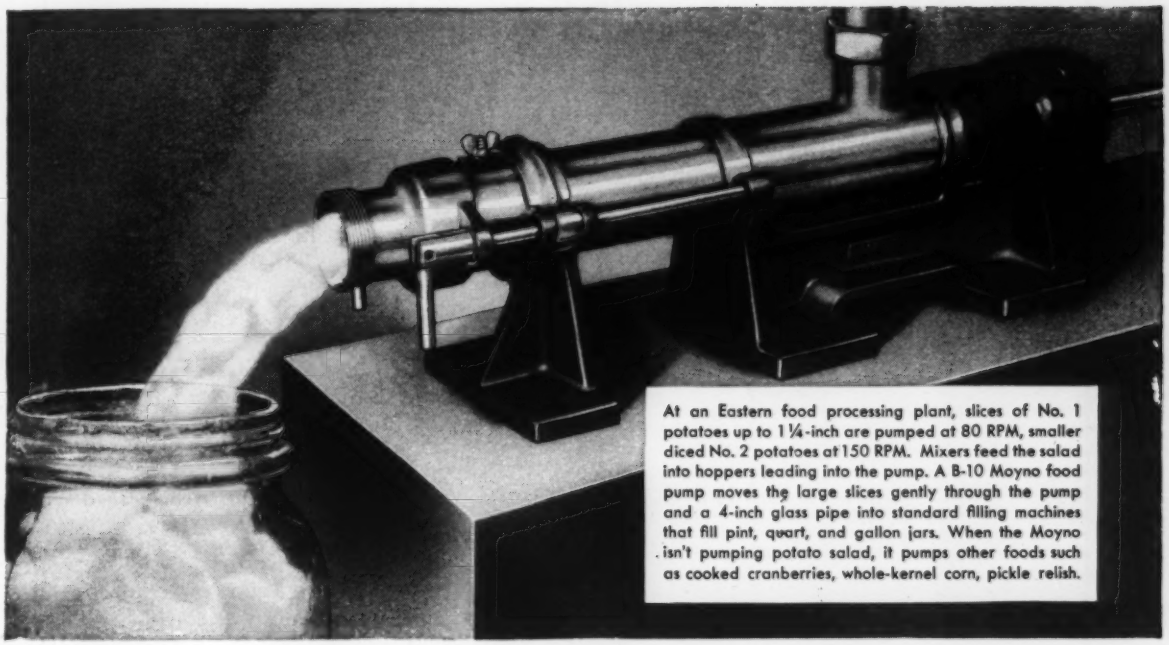
XUM



At an Eastern food processing plant, slices of No. 1 potatoes up to 1¼-inch are pumped at 80 RPM, smaller diced No. 2 potatoes at 150 RPM. Mixers feed the salad into hoppers leading into the pump. A B-10 Moyno food pump moves the large slices gently through the pump and a 4-inch glass pipe into standard filling machines that fill pint, quart, and gallon jars. When the Moyno isn't pumping potato salad, it pumps other foods such as cooked cranberries, whole-kernel corn, pickle relish.

Unusual Pumping Problem? Maybe This Moyno® Pump Can Help You Solve It

The Moyno can pump potato salad and a lot of other materials without making mush out of them—because of the unique *progressing cavity* principle.

Moynos have no valves and pistons, no vanes or other devices that cause churning and turbulence. The Moyno has a simple screw-like rotor turning within a double-threaded stator. This design creates cavities which progress smoothly toward the discharge end of the pump, carrying the material being handled. The material is not squeezed or churned.

Pumps Practically Anything

That's why the Moyno successfully handles such hard-to-pump materials as non-pourable pastes, frits, plaster, highly volatile liquids, and materials containing large particles, such as potato salad, fruit, cherries, chow mein—even oysters! In fact, the Moyno handles practically anything that will pass through a pipe.

Wide Range of Sizes

Moynos pump many hard-to-pump materials with a minimum of abrasion and wear. Many plants have adopted Moynos simply because they last so long.

Moynos provide positive displacement. Moynos can pull up to 29 inches vacuum while discharging under pressure. Big Moynos deliver up to 500 gpm; can provide pressures up to 600 psi in the smaller frame sizes. They even get up to 1000 psi momentarily.

The Moyno is reversible—it pumps equally efficiently in either direction.

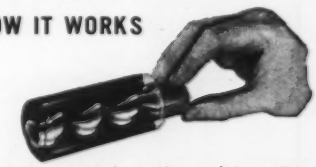
With the Moyno, accurately metered flows are obtainable by regulating operating speed.

Moynos are trouble-free. They are self priming; won't cavitate or vaporlock. There's just one moving part—no valves to stick, no pistons to gum up. Built for tough service. Easy to maintain. Moyno pumps are easy to take apart for cleaning.

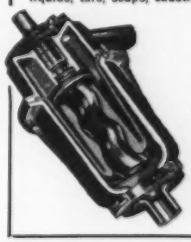
Write For Bulletin

You may save a good deal of money or solve a tough problem by finding out about this simple, versatile pump. Write for Bulletin 30MD.

HOW IT WORKS



Rotor is like a stretched-out corkscrew. It turns within a stator that has a double internal thread. Thus rotor and stator form closely fitted cavities. As the rotor turns, these cavities progress evenly toward the discharge end of the pump without closing up. That's why the Moyno easily handles materials without crushing, churning, or aerating; and why it can handle so many different things—solids in suspension, pastes, abrasives, highly volatile liquids, tars, soaps, caustics—even cement and plaster.



FOR DESIGN ENGINEERS

Moynos are available in small sizes and special designs for use in automatic washers, drink dispensers, sprayers, oil burners, machine tools, gasoline pumps, and a wide variety of other equipment. If you are designing machinery, we'll work with you, in confidence, to integrate pump design with your problem.

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

R&M®

Fractional and Integral HP Motors

Desk, Window, and Household Fans

Hoists and Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

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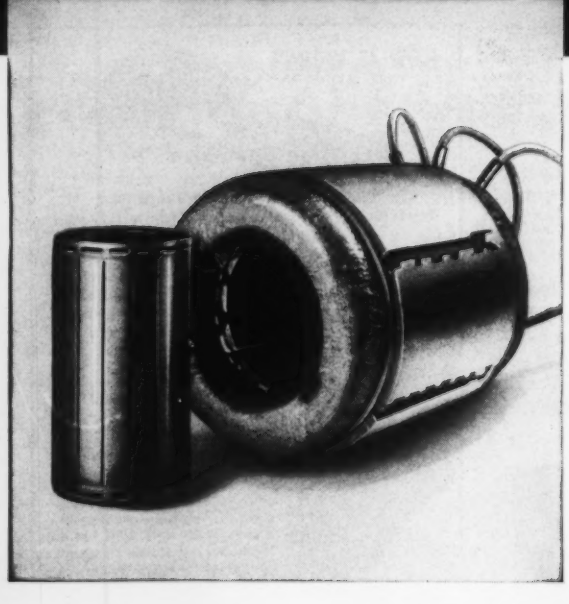


R&M MOTOR PARTS AT WORK

A prominent passenger car manufacturer gets eleven times more chassis per gallon—reducing paint and production costs substantially—with the efficient, high-quality electrostatic paint spray process of the Ransburg Electro-Coating Corp., Indianapolis, Ind. Robbins & Myers polyphase motor parts are utilized to atomize the paint spray in an electrostatic field. The spray is attracted to the products, which are grounded through the hanger, producing a high degree of uniformity of finish.

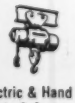
◀ Rugged rotor and stator for a polyphase portable tool. The rotor consists of squirrel cage, embedded in laminated core with bars and end rings of copper, brazed or welded together. The stator has a high-grade silicon steel core with top-quality rag paper used to insulate the coil from the core. The finished winding is taped and thoroughly impregnated with high-grade synthetic resin base varnish to assure trouble-free operation with minimum danger of short circuits and grounds.

ROBBINS & MYERS, INC.

MOTOR DIVISION: SPRINGFIELD 99, OHIO • BRANTFORD, ONTARIO

Fractional & Integral h.p. Motors & Generators

Household Fans



Electric & Hand Hoists & Cranes

Moyno Pumps

Propellair Industrial Ventilating Equipment

R & M SPECIALISTS INTEGRATE MOTOR AND MACHINE DESIGNS... TO ASSURE HIGHEST PERFORMANCE

Many factors must be considered in designing a new motor-operated product that will perform its intended functions accurately, economically, and with a low maintenance and failure rate. Much depends on the proper correlation and integration of motor and machine designs. A special knowledge of motor application can be valuable to you. Robbins & Myers motor design specialists can help you solve these problems, to whatever extent you desire.

The exact motor for your machine is worked out quickly and accurately, with systematic methods of designing motors. This might include, for example, the use of R & M's unique "Electrical Slide Rule." Electrical equivalents can be set up on the slide rule to simulate the conditions under which the motor must operate in your product. By this method we are able to investigate hundreds of different design possibilities, assuring the best motor for the job.

In some cases the answers point to a standard motor. And here, R & M offers a wide variety of types and sizes of complete motors or matched motor parts.

In other cases special motors are indicated. R & M is equipped to do a fast, thorough, economical job of custom-designing a motor that's exactly right for your product.

Don't settle for an "off-the-shelf" compromise. Standard or custom-designed, R & M will get you the right answer quickly —with no obligation!

R & M MOTORS AND MOTOR PARTS POWER MANY TYPES OF EQUIPMENT, SUCH AS . . .

- Portable Saws
- Drills
- Nibblers
- Lock Mortisers
- Valve Grinders
- Vacuum Cleaners
- Fans
- Sanders
- Routers
- Screw Drivers
- Pumps
- Compressors
- Hones
- Business Machines
- Cast Cutters
- Food Mixers
- Nut Setters
- Hammers
- Polishers
- Planers
- Portable Grinders
- Sirens
- Advertising Devices
- Ventilating Equipment
- Hedge Trimmers
- Lawn Mowers
- Oil Burners
- Surgical Instruments
- Grease Guns
- Vibrators
- Die Sinkers
- Waxers

R&M MAKES BOTH!
Fractional-horsepower motors and parts . . . from 1/200 h.p.

If it's an R&M, it's the Right Motor!

Integral-horsepower motors; famous R&M "All-Weather"* with sealed bearings. Up to 200 h.p.

*"All-Weather" is an R & M trademark

This coupon will bring you prompt information. MD

Robbins & Myers, Inc., Motor Division, Springfield 99, Ohio

Please send me, without obligation, information on:

- ☐ Motor Parts for Portable Tools
- ☐ Universal Motors
- ☐ Capacitor Motors
- ☐ R & M "All-Weather" Motors —up to 200 h.p.
- ☐ Please have a Motor Specialist call

Product we manufacture: _____

Name _____

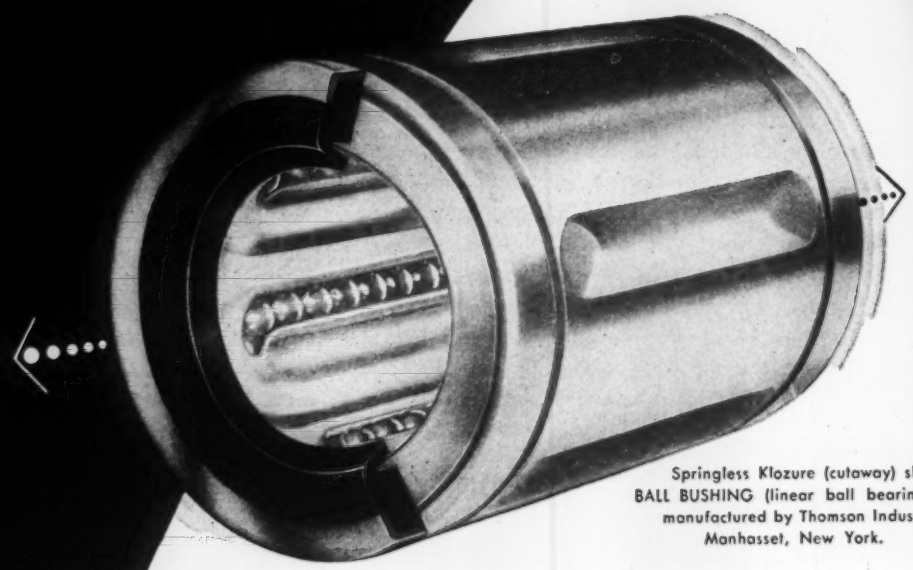
Title _____

Company _____

Street _____

City & State _____

ONE OF THE GARLOCK 2,000



Springless Klozure (cutaway) shown on a BALL BUSHING (linear ball bearing) manufactured by Thomson Industries, Inc., Manhasset, New York.

First Choice

FOR LINEAR MOTION, TOO!

Klozure* Oil Seals Protecting bearings from dust and other contamination is as important in linear applications as it is in rotary bearing applications. That's why Thomson Industries, selected Garlock Klozure Oil Seals Model 71-A for their linear ball bearing. Thomson found that the unique design of the 71-A and its synthetic rubber sealing element made it ideal for their limited space, low pressure, grease retaining application.

Let us show you how one of "the Garlock 2,000" can help you . . . you can choose from two thousand different styles of packings, gaskets, and seals to meet all your needs. It's the only *complete* line . . . it's one reason you get *unbiased* recommendations from your Garlock representative. Call him today or write for Klozure Catalog 10.

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, *contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.*

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

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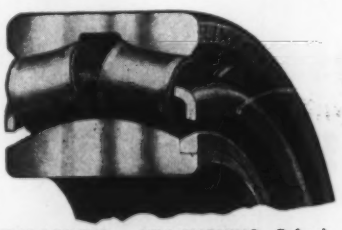
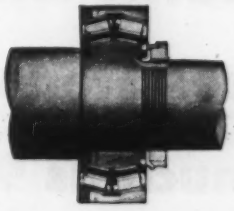
MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings

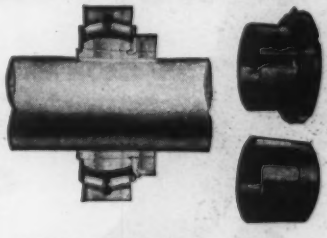
ALLIS-CHALMERS MOTOR GRADER capitalizes on the ability of Link-Belt self-aligning roller bearings to handle high shock loads.



FREE-ROLLING — SELF-ALIGNING. Spherical inner ring is free to align in any direction. Load is distributed over entire roller assuring full load capacity. Destructive edge loading cannot occur.



DIRECT SHAFT MOUNTING with bearing being pressed or shrunk on the shaft. Especially desirable to achieve maximum economy on production applications.



ADAPTER MOUNTING permits use of commercial shafting without machining. Easy installation and removal of adapter-type bearings are provided by the tapered sleeve, locknut and lockwasher.

Builders of industry's heaviest equipment

choose this self-aligning roller bearing for toughest applications

You're in company with blue-chip machinery makers when you specify high-capacity Link-Belt self-aligning roller bearings. Wherever tough-duty equipment calls for self-contained, pre-adjusted bearings and simple mounting, you'll find them on the job . . . handling heavy radial and thrust shock loads.

These self-aligning roller bearings have internationally standardized boundary dimensions and are available everywhere. Link-Belt also makes industry's most complete line of ball and roller bearing blocks. This includes pillow blocks plus flange, flange cartridge, cartridge, take-up and hanger blocks. Ask any one of the 40 Link-Belt offices for data Book 2550.

LINK-BELT

Ball and Roller Bearings 13,003-A

Bearing boundary dimensions are international standards for Series 22200 and 22300—22500-A and 22600-A.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

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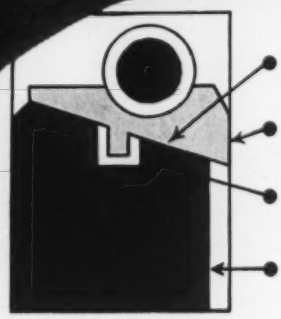
Tapered for positive suspension.
High radial sealing surface.
"Tongue and groove" for easy installation.
Clearance for radial motion.

KOPPERS HUHN CARBON RING

Reduces Steam Loss as much as 90%!

The unique design of Koppers Huhn Carbon Ring reduces steam loss far below the customary 1% loss of labyrinths and carbon garter spring rings. Huhn Carbon Ring keeps steam loss as low as ¼ of 1% . . . often as little as 1/10 of 1%. Using your own figures for steam costs, you can easily discover how much Koppers Huhn Carbon Rings can save you annually.

The design assures you continuous radial sealing . . . because a radial sealing surface is always forced against a chamber wall. Automatic suspension . . . even during shutdowns . . . prevents shaft contact, reduces wear, and prolongs life. The Huhn Carbon Ring operates with peak efficiency at highest shaft surface speeds and highest operating temperatures.

Koppers Huhn Carbon Ring replaces labyrinths and carbon garter spring rings in compressors, and steam and water turbines. Steam savings alone often pay within a year for the cost of replacement. Discover now how Huhn Carbon Rings reduce steam and fluid losses and minimize operating, maintenance and repair costs. Write: KOPPERS COMPANY, INC., *Piston Ring and Seal Dept.*, 2307 Hamburg St., Baltimore 3, Md.

Koppers Company, Inc.
Metal Products Division
Piston Ring and Seal Dept.

***Engineered* Products**
Sold with *Service*

KOPPERS®

MECHANICAL SHAFT SEALS

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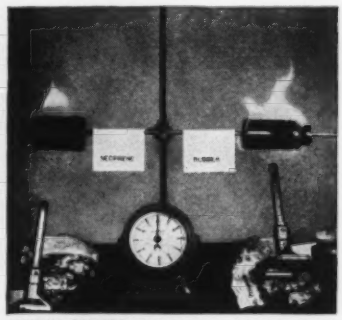
DU PONT ELASTOMERS

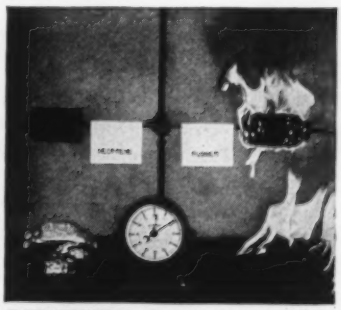
NEOPRENE – HYPALON

4 in Design

NEOPRENE ROLLERS PASS FLAME TEST!



PRINTING ROLLERS of neoprene (left) and natural rubber (right) are exposed to the flame of Bunsen burners until they ignite.



IN FIVE SECONDS after burners are removed, flame on neoprene roller is out. After 69 seconds, drippings from flaming rubber roller have ignited newspaper.

This test convinced management of the New York *Daily News* that neoprene printing rollers offer an extra measure of safety over natural rubber. Today, they flame test all rollers before they buy—and neoprene rollers are the only rollers that meet the test.

Neoprene's resistance to flame may well be useful to you as an added safety factor in your product designs. And neoprene offers resistance to abrasion, oil, heat, and chemicals as well. For all general-purpose applications, you can count on neoprene for long-term service. Clip coupon for further information.

Resilient gaskets of HYPALON® unaffected by 2% ozone

Re-usable after 2 years in ozone generators

For two years now Emery Industries has been using HYPALON synthetic rubber gaskets to seal its ozone generators. The company's ozone-producing installation is the largest in the country. Its operations supervisor, Robert Peters, made this report on HYPALON. "No failures with HYPALON gaskets in two years, even though they've been exposed to 2% ozone."

Design of the generator

The generator used by Emery Industries consists of a steel shell packed with a series of glass tubes individually encased in an electrically charged metal enclosure. A conductor carries an opposing charge through the glass tubes to make, in effect, a large electrical condenser. Dry oxygen is passed along the length of the glass tubes and converted to ozone. The generators are closed at each end by a dished head sealed with HYPALON gaskets.

HYPALON replaces plastic

Formerly, plastic gaskets were used in the generator. While unaffected by ozone, plastic gaskets had to be replaced after each maintenance checkup because they were too rigid for re-use. HYPALON gaskets, even after two years of service, retain their resilience and are still re-usable. Says the generator manufacturer, Welsbach Corporation, in Philadelphia: "We use HYPALON gaskets because they have the best over-all combination of properties of any we've found—including ozone inertness, resilience and cost."

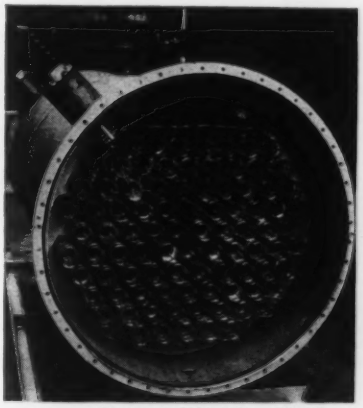


Photo courtesy Welsbach Corp., Phila., Penna.

HYPALON gasket on ozone generator showed no sign of deterioration after two years of service.

Designing with HYPALON

HYPALON means extra-long life at lower operating costs for resilient products subject to severe service conditions. It can operate at temperatures from 250°F. to 350°F. It is particularly resistant to most oxidizing chemicals. And HYPALON resists weather and sunlight attack and can be compounded in an unlimited range of stable colors. For more information about HYPALON, clip and mail the coupon below.

DU PONT

REG. U. S. PAT. OFF.

HYPALON *is a registered trademark of E.I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Please send further information and add my name to the mailing list for your free publications, the "Neoprene Notebook" and "Facts about HYPALON®," which show how the Du Pont elastomers are used in designing new products, improving old.

E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division, Dept. MD-7
Wilmington 98, Delaware

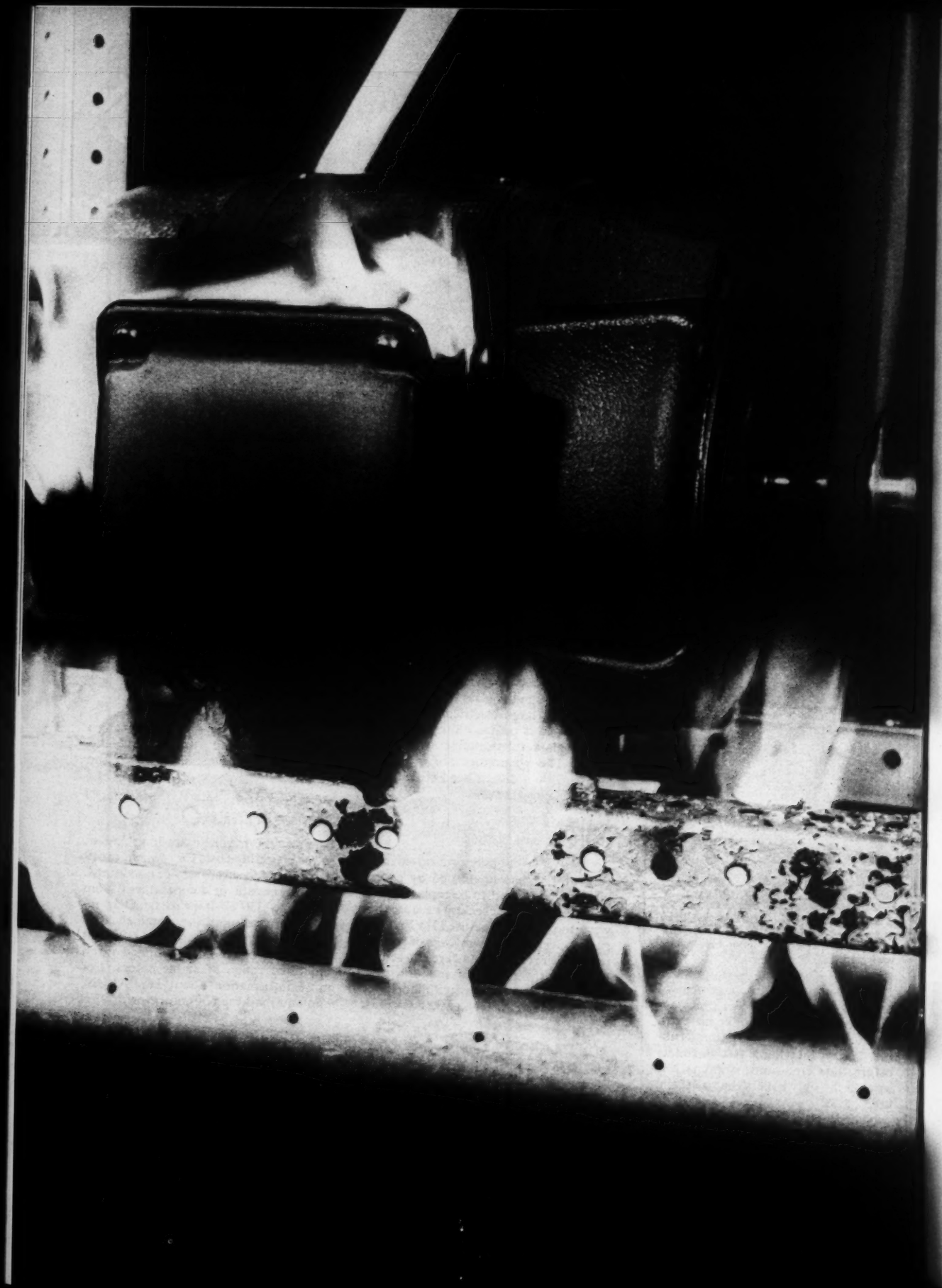
Name_____ **Position**_____

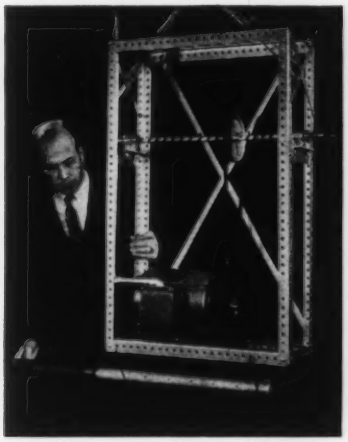
Firm_____

Address_____

City_____ **State**_____

XUM





TOMORROW:

A standard motor that can survive infinite heat

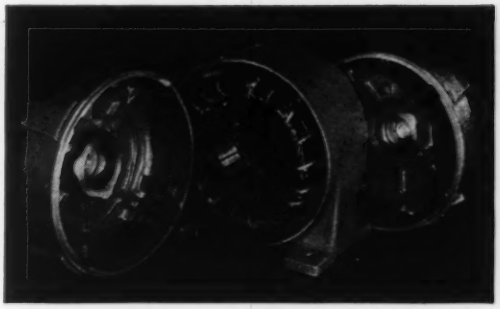
The new Life-Line A is another step closer

Westinghouse is working on tomorrow's motor today. Investigating new materials—testing existing motor designs.

No standard motor today can survive the ultimate test shown here. But we do know that the new Life-Line® "A" can operate under higher temperatures than ever before. It has stronger insulation and better bearing protection than any other motor on the market. It's industry's closest approach to a standard motor that is absolutely heatproof.

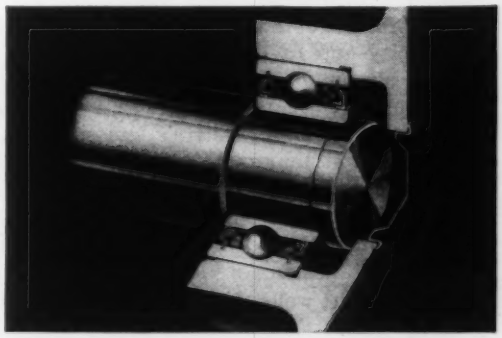
Your Westinghouse sales engineer can show you many additional reasons why the Life-Line "A" is industry's most advanced and preferred motor. Call him today.

J-21926



New fortified insulation includes exclusive Bondar, Bondite and Mylar*—three good reasons why the Life-Line "A" is so resistant to heat or any other motor contamination.

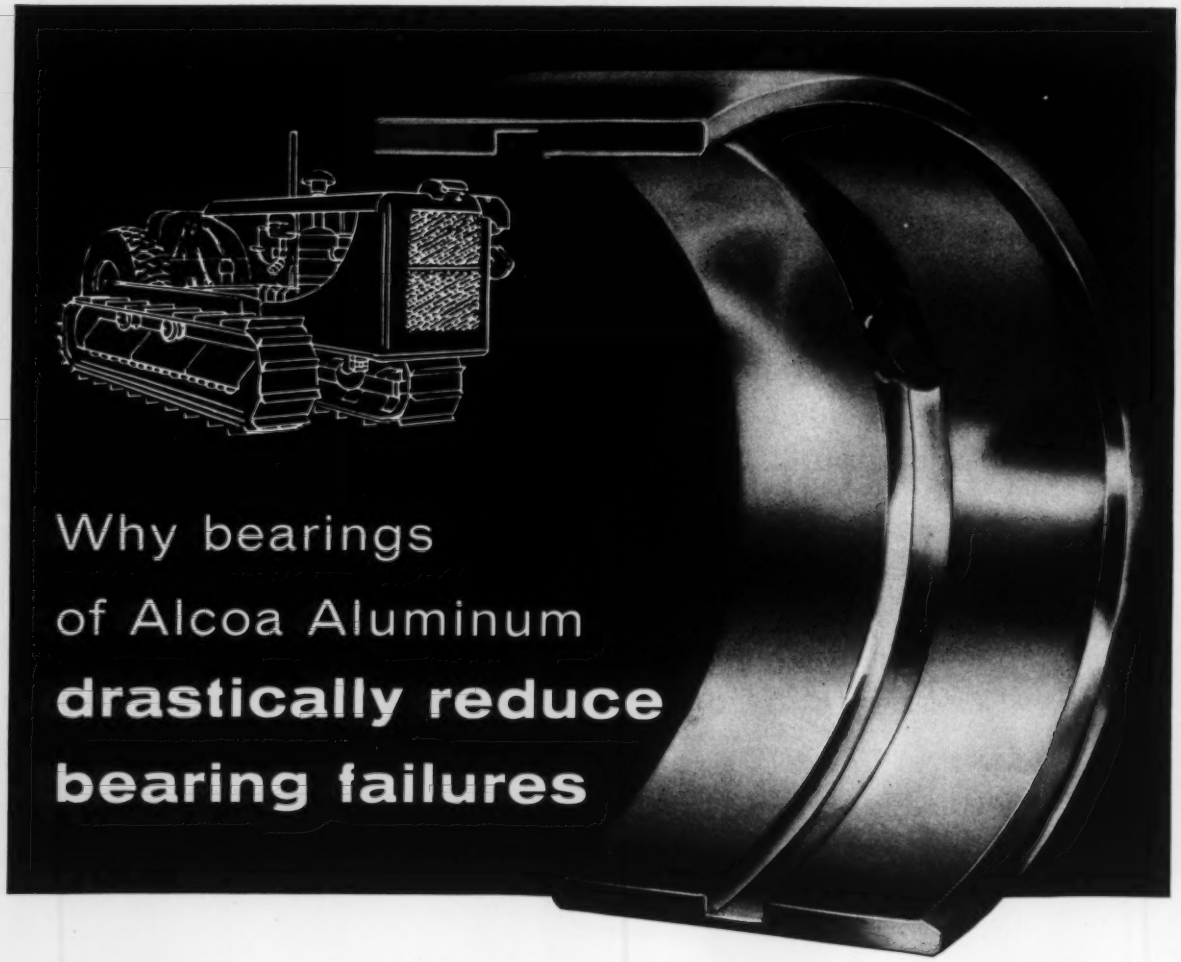
*DuPont Registered Trade-Mark



Two outer seals of new 4-way sealed bearing act as flingers and literally throw off damaging contaminations. Inner seals, attached to outer bearing race, are stationary and form a positive labyrinth.

WATCH WESTINGHOUSE!

WHERE BIG THINGS ARE HAPPENING TODAY!



Why bearings of Alcoa Aluminum **drastically reduce bearing failures**

A major implement company switched to solid aluminum for main connecting rod and thrust bearings in tractors. Result: a *drastic* reduction in bearing failures . . . *much* longer bearing life.

In hundreds of different kinds of applications solid aluminum bearings are outperforming bronze and babbitt because aluminum has an *unmatched combination of advantages.*

Highest load capacity—No other material is in the same league with aluminum for load-carrying capacity—up to 10,000 psi on projected area. Only aluminum can be used for solid bearings in heavy-duty service.

20° cooler running—There's less chance of seizure with aluminum bearings—they run up to 20° cooler than others.

Excellent conformability—Aluminum is a very ductile metal, conforms readily to misalignment or nonparallelism.

Handles dirt well—Aluminum embeds dirt particles better than bronze but not as deeply as babbitt. Dirt rolls out easily and into the filter.

No corrosion problem—Oil additives don't hurt aluminum bearings. No protective coatings are needed.

No failure damage—With solid aluminum bearings there is, of course, no hard backing material to damage the shaft in event of bearing failure.

Great design flexibility—Aluminum bearing alloy is also a *structural* material so you can do such interesting things as designing rocker arms and connecting rods that need no bearing inserts, or water-cooled bearings with integral cooling passages.

Find out more about cast bearings of solid Alcoa® Aluminum. Check your bearing manufacturer or write: Aluminum Company of America, 1986-G Alcoa Bldg., Pittsburgh 19, Pa.

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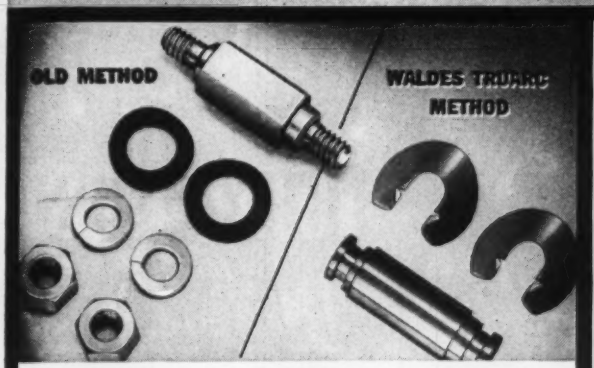
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

WE CHOSE
ALCOA
ALUMINUM
MILL PRODUCTS
ALUMINUM COMPANY OF AMERICA

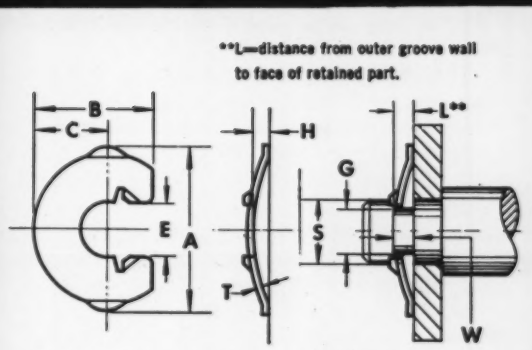
Your Guide to the Best in Aluminum Value

—ITEM 540—
For More Information Circle Item Number on Yellow Card—page 19

New Waldes Truarc locking-prong ring functions as spring, shoulder, fastener... and STAYS PUT!



Above assembly shows how 2 Waldes Truarc Locking-Prong Rings (Series 5139) replaced 6 parts... eliminated threading operation... and need for skilled labor.



WALDES TRUARC LOCKING-PRONG RING (Series 5139)

U. S. Pat. Pending

Ring No. 5139–	SHAFT		RING DIMENSIONS												average ultimate shear strength lbs.*	GROOVE DIMENSIONS						resilient end play take up L max– L min
	Dia. S	tol.	A	tol.	B	tol.	C	tol.	E	tol.	H	tol.	T†	tol.†		Dia. G	tol.	Width W	tol. −.000	L min.	L max.	
12	.125	±.002	.340	±.010	.307	±.010	.166	±.005	.086	±.004	.050	±.010	.010	±.0013	400	.082	± 0015	.045	+.005	.035	.045	.010
★15	.156	±.003	.380	±.010	.330	±.010	.184	±.005	.108	±.004	.055	±.010	.010	±.0013	600	.104	±.002	.050	+.005	.035	.045	.010
18	.188	±.003	.445	±.010	.390	±.010	.213	±.005	.130	±.005	.060	±.010	.015	±.0015	900	.124	±.002	.065	+.005	.045	.055	.010
25	.250	±.003	.581	±.010	.500	±.010	.280	±.005	.172	±.005	.070	±.010	.015	±.0015	1000	.165	±.002	.070	+.005	.050	.065	.015
31	.312	±.003	.744	±.010	.620	±.010	.360	±.005	.234	±.005	.095	±.010	.018	+.001 −.002	1300	.228	±.003	.080	+.005	.080	.095	.015
★37	.375	±.003	.853	±.015	.740	±.010	.427	±.005	.280	±.005	.130	±.010	.020	±.002	1900	.270	±.003	.105	+.005	.090	.115	.025
★43	.438	±.003	.960	±.020	.820	±.020	.475	±.010	.337	±.010	.130	±.010	.020	±.002	2200	.327	±.003	.105	+.005	.095	.120	.025

Additional Sizes Under Development ★Production dies not available as of date of printing †Applies to unplated rings only *Recommended safety factor =3 to 4.

The Waldes Truarc Locking-Prong Retaining Ring is a new, low cost, radially applied fastener which can be locked positively in its groove and used as a shoulder against rotating parts. It is primarily intended for use in the automotive, electronic and aeronautical industries.

This radially applied ring locks positively in its grooves by means of two prongs at the open end. Because of its high thrust-load capacity the Waldes Truarc Locking-Prong Ring may be used as a shoulder against rotating parts. Its bowed construction provides for end-play take-up in the assembly and makes less critical the tolerances required for the parts being fastened. Since it serves as a spring as well as a shoulder, this ring eliminates the need for springs, washers, and other accessory fastening devices.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

SEND FOR FREE SAMPLES

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.

☐ Please send me sample Locking-Prong Rings. (please specify shaft size_____)

☐ Please send me supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.

(Please print)

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____

MD-878

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787. and other U. S. Patents pending. Equal patent protection established in foreign countries.

LINDBERG INDUCTION UNIT IMPROVES HEAT TREATING PROCESSES AT J.I. CASE...

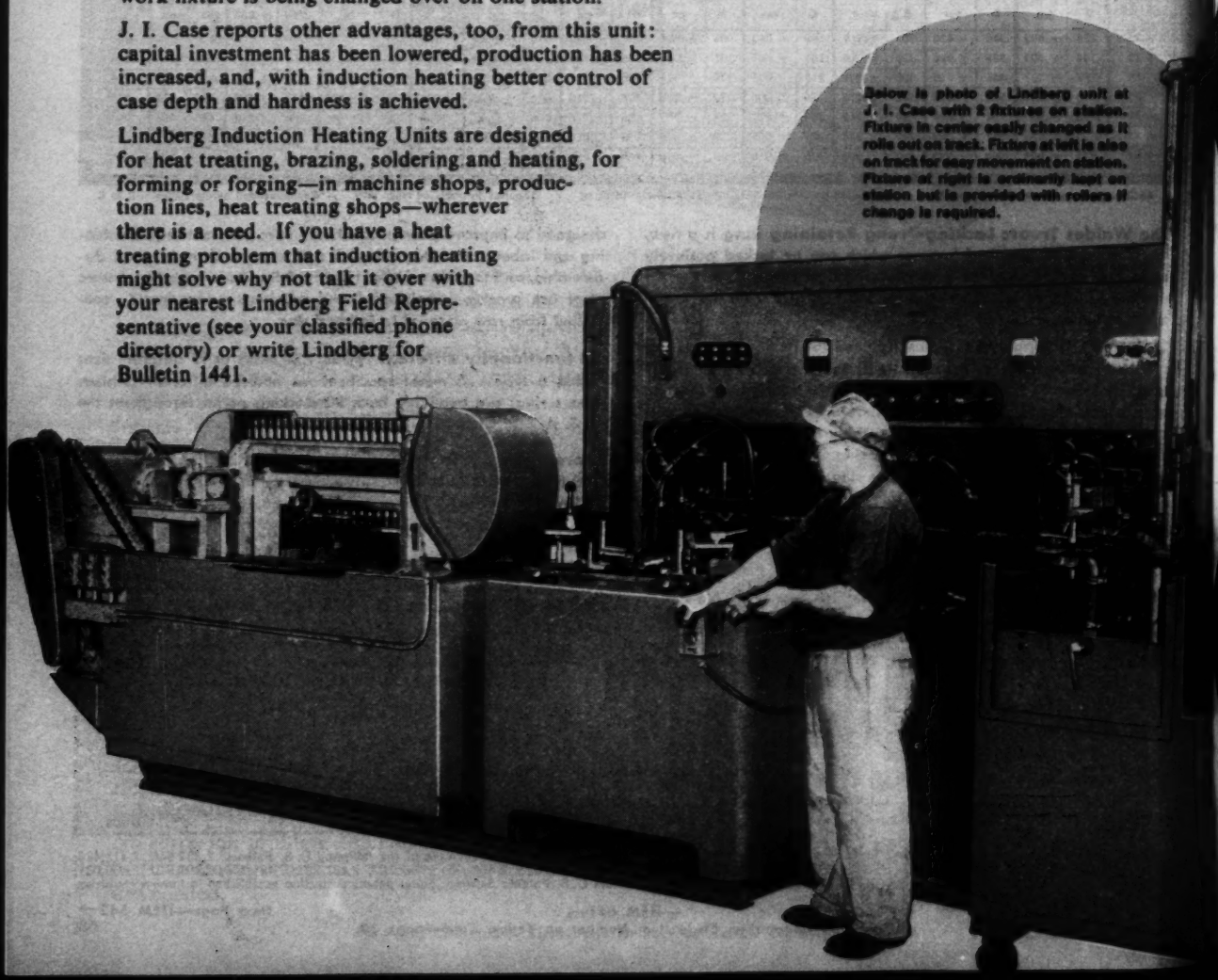
SAVES ½ ITS TOTAL COST— IN 1 YEAR!

A single Lindberg 2-station High Frequency Induction Heating Unit at J. I. Case Co., Racine, Wisc., is providing a happy combination of sizeable cost savings and improved quality and production efficiency in heat treating parts for Case tractors. Actually, the dollar savings effected with this Lindberg unit will repay its total original cost in *less than 2 years!*

This single unit and the five work fixtures provided with it, working on 2 to 3 shifts, 5 days a week to meet production requirements, heat treat some 63 separate tractor parts. Work fixtures are readily changeable, set-up time is materially reduced, and because of the 2-station design, the unit can operate continuously while work fixture is being changed over on one station.

J. I. Case reports other advantages, too, from this unit: capital investment has been lowered, production has been increased, and, with induction heating better control of case depth and hardness is achieved.

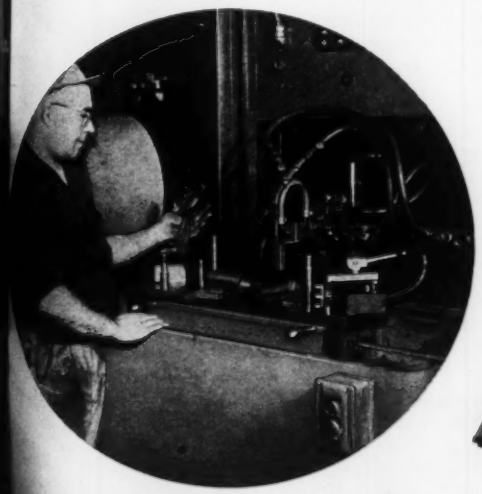
Lindberg Induction Heating Units are designed for heat treating, brazing, soldering and heating, for forming or forging—in machine shops, production lines, heat treating shops—wherever there is a need. If you have a heat treating problem that induction heating might solve why not talk it over with your nearest Lindberg Field Representative (see your classified phone directory) or write Lindberg for Bulletin 1441.



Below is photo of Lindberg unit at J. I. Case with 2 fixtures on station. Fixture in center easily changed as it rolls out on track. Fixture at left is also on track for easy movement on station. Fixture at right is ordinarily kept on station but is provided with rollers if change is required.

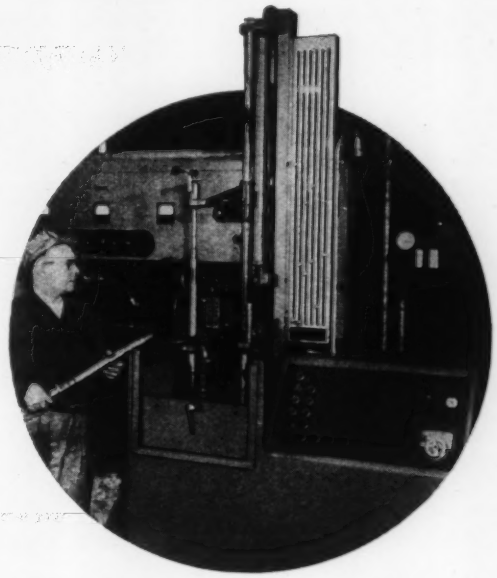
(Above) Hydraulic male coupling is being treated on this fixture. 3 other parts are treated by it, too.

(Above) This shows fixture handling inlet and exhaust valve rocker arms. Same fixture treats 6 other parts.



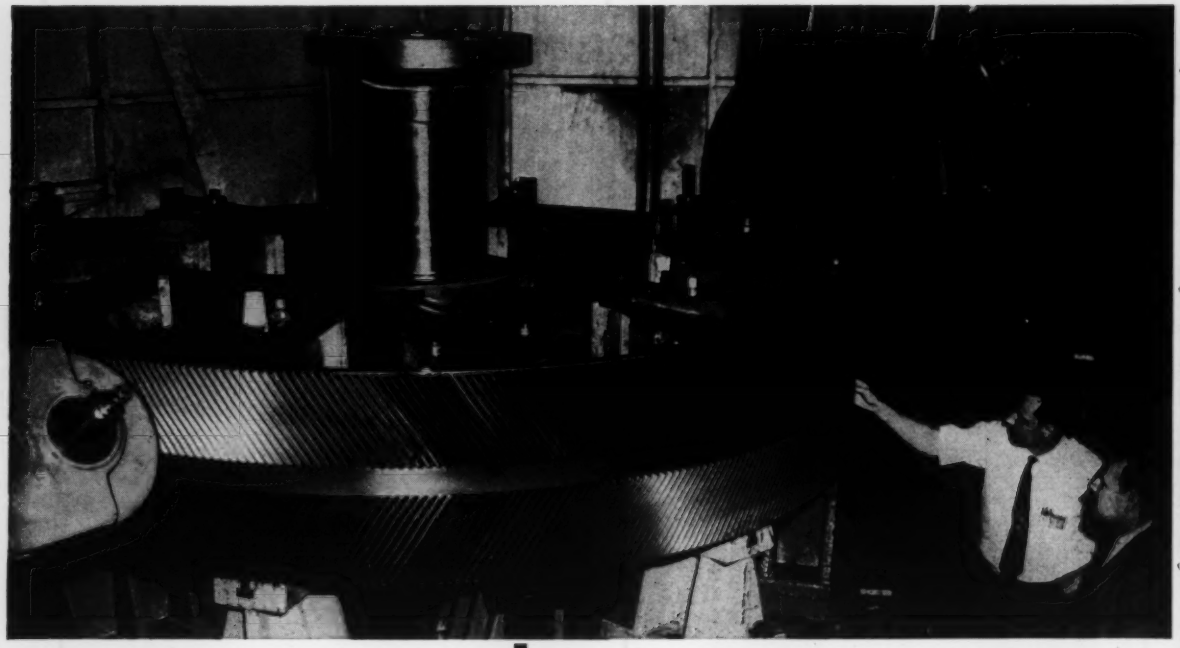
(Above) This fixture is selectively hardening pads and slots on shifter forks. It is also used for treating 17 other parts.

(Below) This fixture is shown selectively hardening a front axle king pin. It handles piece up to 45¼" long, 35" of which can be scanned to desired depth. It is also used for 34 other parts.



(Below) Power take-off hydraulic drive shafts are one of the 3 parts treated by this fixture.

LINDBERG
HIGH FREQUENCY DIVISION
Lindberg Engineering Company
2473 West Hubbard St., Chicago 12, Ill.



Precision high speed herringbone gear, 119" diameter, 4 pitch, A.G.M.A. Class 4, Rockwell hardness C33, concentricity tolerance .0006 between pitch diameter and journals. Maximum error of lead .0005 in entire face width of gear. Helix angle 37° 57 mins., 18" face width, 477 teeth.

are your gear tolerances "impossible"?

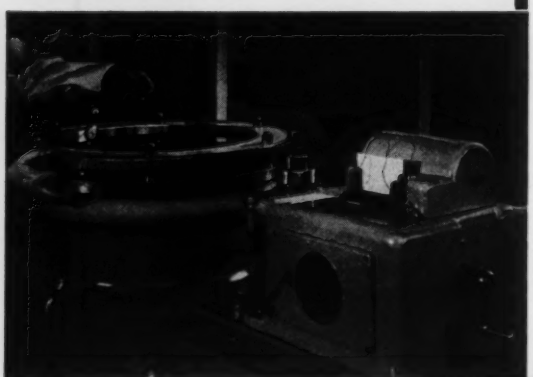
... then call WESTERN GEAR

When large external precision gears more than 42" in diameter are called for, they are cut on a 120" precision hobbing machine as shown at top, equipped with two index systems, one for roughing, the other for finishing to preserve the accuracy of the machine.

For large precision external gearing under 40" in diameter, a special 72" hobbing machine is used, equipped with index system limiting the machine to cutting large numbers of teeth only. Machines use Class AA hobs on specially made hob arbors and spindles.

Large precision internal gears are cut in a shaper of 72" capacity especially rebuilt to hold accuracy. All large precision gears in this category are shaved in special shaving machines having a capacity of 60". Careful temperature control is constantly maintained and rigid inspection is a by-word.

The manufacture of gears to total composite errors of .0005 and tooth-to-tooth errors of .0002 is an everyday occurrence at Western Gear! Technical know-how and unexcelled manufacturing facilities enable Western Gear to produce high quality gears to "impossible" tolerances in production line quantities. If precision quality gears are your problem, call on Western Gear skill and experience. We do the job when others fail!



"Red liner" machine, redesigned especially by Western Gear to insure utmost accuracy, in use to check accuracy of 26" fine pitch instrument gear.

"The difference is reliability" • Since 1888

5612

WESTERN GEAR *Corporation*

ENGINEERS AND MANUFACTURERS

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.) SEATTLE AND HOUSTON • REPRESENTATIVES IN PRINCIPAL CITIES

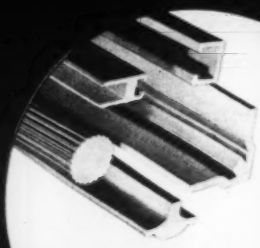
not just brass but

Titan brass

mill products...for your metal money's worth

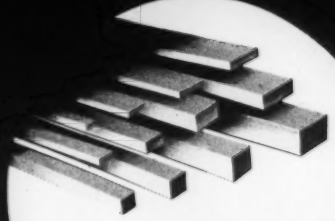
Brass rounds available from 1/16" to 10" diameter.

Rounds



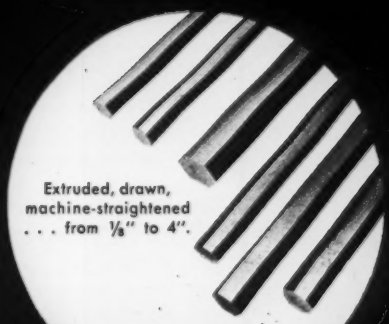
Extruded to your exact requirements.

Special Shapes



Squares up to 4¼". Rectangles extruded, drawn and straightened—up to 5" maximum diagonal.

Rectangles & Squares

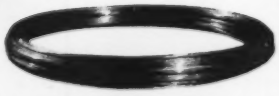


Extruded, drawn, machine-straightened . . . from ⅛" to 4".

Hexagons & Octagons

Bronze boat shafting . . . tough, strong, corrosion-resistant Titan Naval Brass.

Tru Shaft



High-quality wire for making brass rivets, bolts, screws, other fasteners . . . available in either 65-35 or 70-30 copper-zinc alloys.

Wire

All Titan rod mill products are of highest quality brass. All sizes of finished Titan dies are ready for production and prompt delivery.

Rounds, hexagons, octagons, rectangles, squares and special shapes can be delivered in the following brass alloys: Free-Cutting Brass, Naval Brass, Leaded Naval Brass, Manganese Bronze. Extruded Leaded Nickel-Silver and Free-Cutting Commercial Bronze in limited sizes and shapes.

Send us your order.

If you want more details on Titan rod and wire mill products, send coupon below:

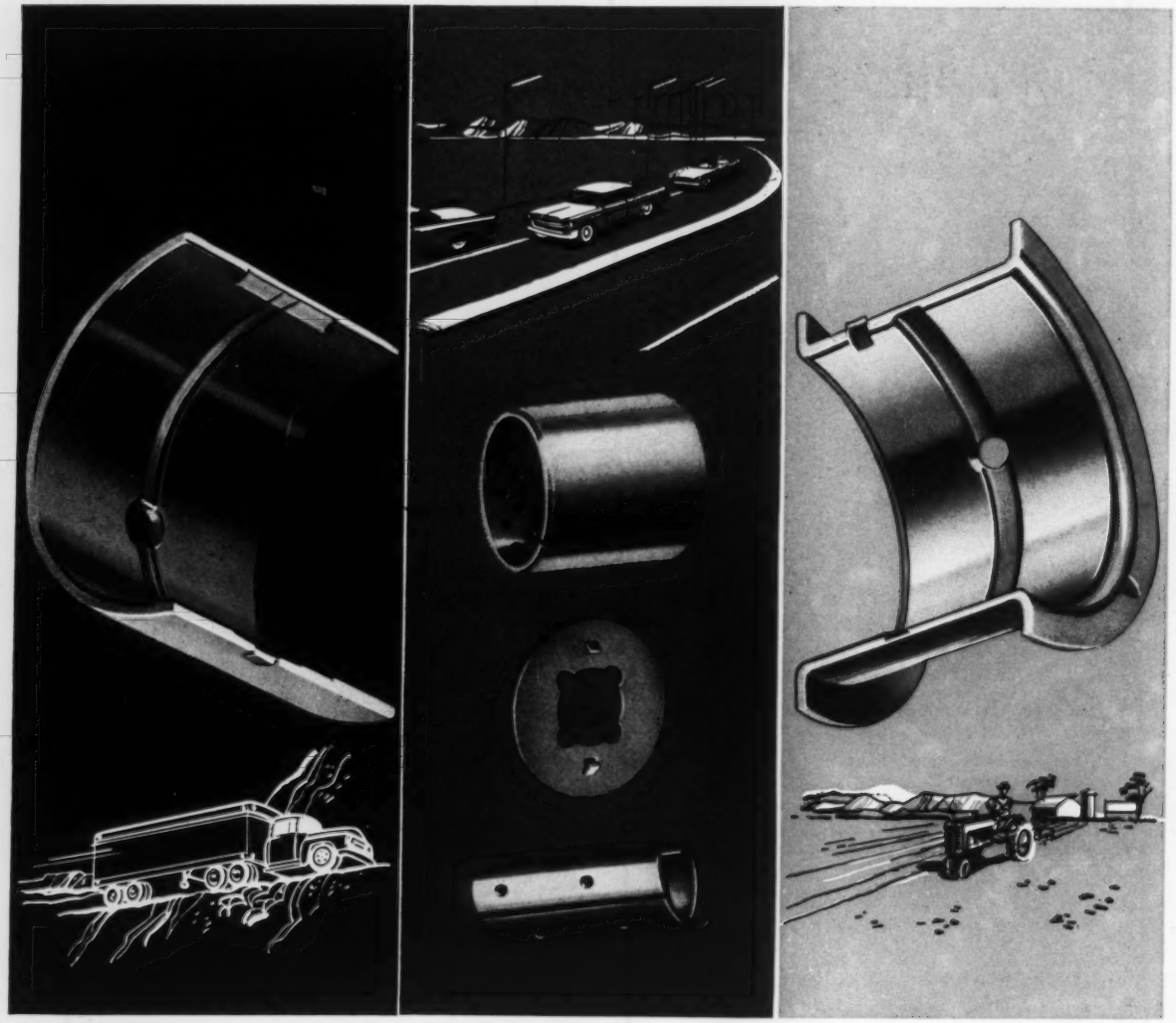
Dept. T-76
Titan Metal Manufacturing Co., Bellefonte, Pa.
Gentlemen:
☐ Please send 20-page brass mill products booklet — "For Your Metal Money's Worth."
☐ Please have your representative call.

Name _____ Title _____
Company _____
Address _____ City & State _____

Titan

RODS • FORGINGS • DIE CASTINGS • WELDING RODS • WIRE

Quality Alloys by Brass Specialists



RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Our 56 years of specialized experience is part of every one of the millions of sleeve bearings we produce each year. It means that each of these bearings will meet the most exacting requirements of practically every type of automotive, industrial and agricultural equipment. We maintain complete facilities for research and engineering, and quality control in all of our plants.

FEDERAL-MOGUL DIVISION

FEDERAL Mogul

SINCE 1899

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11045 SHOEMAKER, DETROIT 13, MICHIGAN

—ITEM 545—

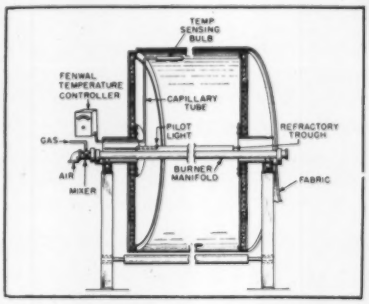
For More Information Circle Item Number on Yellow Card—page 19

Controlling A Radiant-Heat Drying Drum

No. 3 in a series — *Showing the Broad Application Range of Fenwal Controls*

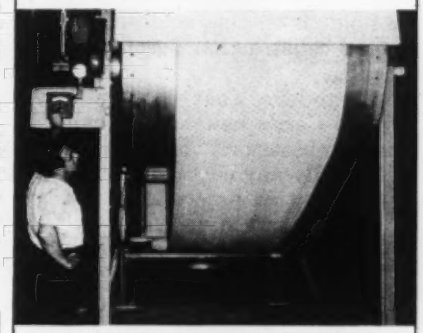
This high-temperature, radiant-heated drying drum is used for drying printed fabrics or for heat-setting synthetic coatings onto fabrics. Particularly interesting is the way in which it combines a Fenwal unit and quick cooling features to secure the close temperature control necessary to prevent scorching the fabric in case of shut-downs.

The drum is usually operated at a surface temperature of 350° to 450°F, but can maintain temperatures up to 700°F, as required. The revolving drum surface is heated by a combination of infra-red rays and convection from a refractory trough heated to incandescence (about 2400°F) by a gas-air manifold burner.



Drum temperature is controlled by a Fenwal Series 540 Indicating Temperature Controller. As shown in the diagram, this is connected by a capillary tube to the temperature-sensing bulb, located close to the interior surface of the drum. The trough and manifold are stationary along the axis of the drum. Flame is played along the surface of the trough by a series of jet nozzles, burning a mixture of air and natural or manufactured gas. To aid in preventing scorching the product, materials used for the drum and heater system are of lowest practical heat capacity. The drum surface is of 16-gauge steel, which assures a low heat content.

Also, the combustion air supply doubles as a coolant for the drum. The air stream is not tied in with the temperature control system and continues to flow after the gas is shut off. Thus, it quickly cools the heater trough and blows the heated air out of the drum. This, plus the low heat capacity of the drum surface, provides the required safeguard against scorching the product during sudden shut-downs.



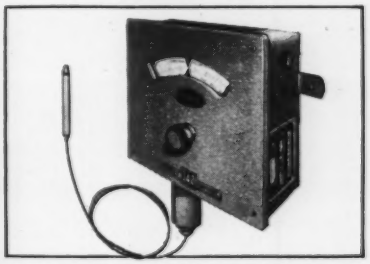
PRECISE TEMPERATURE CONTROL, provided by a Fenwal Series 540 Temperature Indicating Controller (shown at left) is one of the advantages enabling this huge drying drum to set new records for efficiency. In one installation, three 60" diameter drums of this type are drying the same yardage as 20 previously used steam-dryers.

Control Within ¼ of 1%

When the operator sets this Fenwal Series 540 Controller to the required processing temperature, he knows that temperature will be maintained — on the button! Heat input is controlled by the Fenwal unit, actuating a solenoid valve in the supply line. The gas, maintained at atmospheric pressure by a diaphragm regulator, is drawn into a proportioning mixer valve under negative pressure created by the air stream. The air supply, maintained at approximately one psi, reaches the mixer through a separate supply line.

With the Series 540 Control on guard over the heating system, the manufacturer of this advanced drying equipment states that the temperature of the drum surface is maintained within ± one-quarter per cent of the controller scale — outstanding performance for processing equipment of this type.

A Versatile Instrument



The Series 540 Controller is fully adjustable between 100°F and 700°F. Temperature differential is adjustable between 1% and 4% of scale temperature ranges by internal adjustment of pilot contacts. Uniform sensitivity and close accuracy throughout its range are characteristic, making it an ideal temperature indicating controller for kilns, ovens, liquid baths, baking ovens, packaging machinery and general industrial processing.

For Your Own Applications

Investigate the many different types of Fenwal temperature control and detection devices. Besides the Series 540 described here, these include standard THERMOSWITCH® units, Midgets, Miniatures, etc. Send the coupon for new Catalog No. 500. Remember that Fenwal's engineering staff is always ready to help you solve any temperature control problem.

FENWAL INCORPORATED
197 Pleasant Street
Ashland, Mass.

Please send me your Catalog No. 500. Our specific problem is:.....

.....

.....

Name.....*Title*.....

Address.....

City.....*Zone*.....*State*.....

Fenwal CONTROLS TEMPERATURES . . . PRECISELY

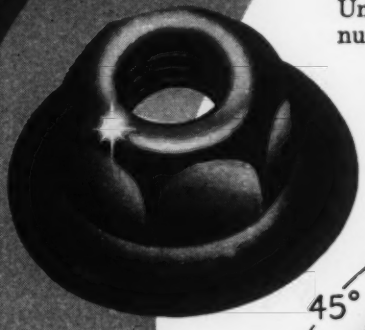
—ITEM 546—

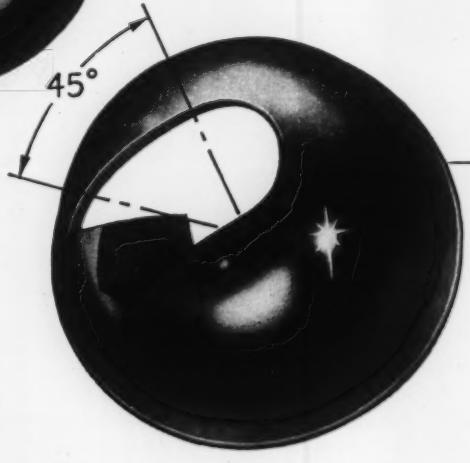
DOT's new angle washer holds cast trim against curves

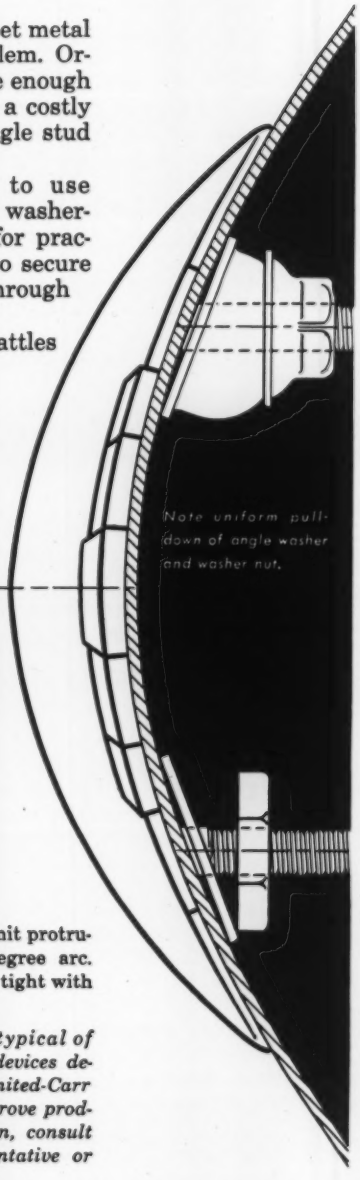
Fastening die-cast trim to curved sheet metal surfaces can be a troublesome problem. Ordinary nuts jam before they get close enough to hold tight. One solution has been a costly mould construction permitting off-angle stud casting.

The modern cost saving way is to use United-Carr's new angle washer and washer-nut combination. This compensates for practically any curve or can be used to secure studs that protrude at an angle through a flat surface.

Tight fastening is assured and rattles never get a chance to start.







Light, strong metal shell is slotted to permit protrusion of stud at any angle within 45 degree arc. Washer nut matches shape of shell, locks tight with normal wrench torque.

The angle washer and washer nut are typical of thousands of special-purpose fastening devices designed and manufactured in volume *by United-Carr to help speed assembly, cut costs and improve product performance. For further information, consult your nearest United-Carr field representative or write us for his name and address.*

[illegible]ARR Fastener Corp.

[illegible] Cambridge 42, Mass.

DOT

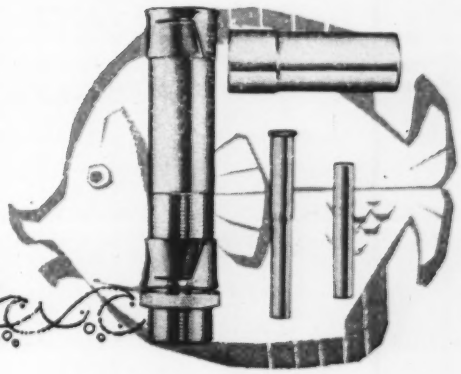
—ITEM 547—
For More Information Circle Item Number on Yellow Card—page 19

Short Cuts to Finished Products . . . *by Anaconda*

Aluminum Ferrules For Fishermen—

Allan Manufacturing Company, Hicksville, N. Y.

As the world's largest producer of fishing tackle hardware, the Allan Mfg. Company serves more than 25,000,000 fishermen. For brass and aluminum, the materials used in large quantity items like the ferrules shown, they turn to The American Brass Company. The reel seat and rod ferrules shown are aluminum, which is later anodized and colored. Allan Manufacturing Company also makes all-brass tackle hardware, using many other Anaconda products.



Red Brass Water Supply Nozzle For Thirsty Hens—

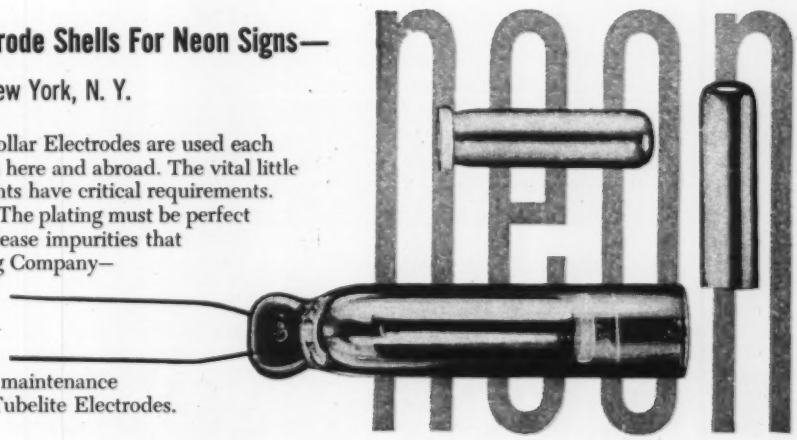
Fox Products Company, Philadelphia, Pa.

The Constant Level Water Valve, made by Fox Products, automatically keeps fresh water available in poultry house troughs to help stimulate maximum growth and egg production. It also protects the health of chickens by shutting off water supply when hens accidentally tip the water trough over. Fox first tried a plastic nozzle on the valve—found it unsatisfactory. Red Brass was a natural for resisting corrosion of the air-water mixture in the nozzle. Instead of tooling up for this part, however, Fox Products found it more economical to have the nozzle made by The American Brass Company.

Nickel-Plated Armco Iron Electrode Shells For Neon Signs—

Tube Light Engineering Company, New York, N. Y.

Millions of these Tubelite Ceramic Collar Electrodes are used each year to keep neon signs glowing, both here and abroad. The vital little nickel-plated iron electrode components have critical requirements. Close tolerances must be maintained. The plating must be perfect —porosity and uneven plating can release impurities that darken tubes. Tube Light Engineering Company—leading manufacturer and distributor of neon tube supplies—turned to the specialized facilities offered by The American Brass Company for both forming and plating, to simplify maintenance of quality standards set up for their Tubelite Electrodes.



The American Brass Company has specialized equipment, such as high-speed multiple-plunger presses, for the economical production of parts like these for industry. It has the experience and skill to design tools which reduce the number of operations and lower production costs—techniques developed over a century of service to manufacturers.

YOUR CHOICE OF METAL: Parts like these can be furnished in copper, brass, bronze, nickel silver, nickel, iron, stainless steel, steel, and aluminum—in a wide variety of finishes.

FOR AN ESTIMATE: Just send a sample, drawing, or description, together with quantity and other pertinent information. Address: The American Brass Company, Waterbury Brass Goods Division, Waterbury 20, Conn.

5668

ANACONDA® **MULTIPLE-PLUNGER PRESS PRODUCTS**

—ITEM 548—

You can make it better

WORLD'S TALLEST MAN-MADE STRUCTURE. 100 ft. higher than the antenna atop the Empire State Building, the 1572 ft. television tower of Station KWTA in Oklahoma City dramatically illustrates the advantages obtainable with USS MAN-TEN Steel in structures where both great strength and light weight are imperative.

USS MAN-TEN Steel supplies the needed strength in the intermediate sections of the tower, 1050 ft. in all, where maximum diameter mild rolled steel rounds were simply not strong enough to carry the load of the tower above.

In the topmost bays, mild steel although strong enough was replaced by lighter, smaller sections of USS MAN-TEN Steel to provide greater or equal strength while at the same time reducing wind resistance so that the structure will be safe in winds up to 150 mph.

RUGGED IS THE WORD. Used in the body liner plates and canopy guard of this 34-ton Rear Dump built by Euclid Division, General Motors Corporation, Cleveland, O., USS TRI-TEN Steel provides 50% greater strength, 60% greater toughness and three times the resistance to atmospheric corrosion of structural carbon steel. And what is of particular importance in equipment like this, that must be able to operate all year around, is TRI-TEN Steel's ability to withstand the shock and impact of heavy, high speed loading even at sub-zero temperatures.

with USS High Strength Steels

In USS High Strength Steels, design engineers have at their command three service-tested steels that will permit them to materially increase the efficiency and economy of machinery, equipment and structures at little or no increase in first cost . . . and frequently, at a saving.

All three of these famous *"steels that do more"*—USS Cor-Ten, USS Man-Ten and USS Tri-Ten—have a 50% higher yield point than ordinary carbon steel. All have better corrosion resistance and offer greater resistance to wear, fatigue and impact. Each, however, has specific superior properties that should be considered in determining its selection.

USS Cor-Ten Steel, for example, is distinguished by its superior resistance to atmospheric corrosion—4 to 6 times that of carbon steel. USS Man-Ten Steel is intended for weight reduction by means of greater strength in moderate forming applications, with enhanced resistance to abrasion and atmospheric corrosion. USS Tri-Ten Steel's outstanding characteristics are excellent weldability and resistance to shock at low temperatures.

Used singly or in combination, these steels can advantageously replace carbon steel to increase the strength and durability of vital parts *without* increasing their weight. Or when the use of thinner sections is feasible, they can (1) reduce equipment weight without reducing its strength, or (2) increase the size and capacity of equipment without increasing total weight or the power required to move it.

• • •

You will find our 174-page *"Design Manual for High Strength Steels"* extremely useful in applying the benefits of these steels to your product. Send for free copy—simply write on your company letterhead to United States Steel Corporation, Room 5320, 525 William Penn Place, Pittsburgh 30, Pa.

HARD-WORKING FARM EQUIPMENT lasts longer, is more dependable when built with USS Cor-Ten Steel. Here used in the main axle and tractor hitch frame of the famous John Deere No. 12-A Combine, USS Cor-Ten Steel gives these vital parts maximum strength, maximum toughness with no increase in weight and at the same time ensures high fatigue resistance—50% greater than that of plain carbon steel. Racking and twisting strains that could easily cause a breakdown are safely absorbed by Cor-Ten Steel's high endurance limit—and the equipment stays on the job.

STRENGTH AND TOUGHNESS are prime requisites in boom boats like this. Used by logging firms to buck logs in the sawmill pond to the log haul-up, these busy little vessels receive very rough treatment, are frequently squashed between the huge logs they handle. To ensure all the strength possible in the hull, sides and bottom are plated with Cor-Ten Steel, welded both inside and out. Cor-Ten Steel's greater abrasion resistance and its high resistance to corrosion also play an important part in prolonging life. (Built by the Ilwaco Boat Works, Ilwaco, Wash.)

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

1933 USS HIGH STRENGTH STEELS 1956
23 YEARS OF PERFORMANCE

USS HIGH STRENGTH STEELS

USS MAN-TEN • USS COR-TEN • USS TRI-TEN

UNITED STATES STEEL

—ITEM 549—

NEW "Unionmelt" Welding Assemblies

for greater job versatility- performance dependability

Versatility and dependability are yours at an all time high in an improved new line of UNIONMELT welding assemblies . . . These units embody the greatest variety of machine combinations, job applications, and design features ever offered for submerged arc welding.

Wire feed units are simply constructed and are highly efficient . . . Identical mounting dimensions for heads, brackets, and slides allow for any number of desired assembly combinations.

Welding heads have exceptional flexibility because of sturdy new mounting fixtures which provide for vertical, horizontal, and rotary adjustment. Stationary and self-propelled combinations are also available.

The wide variety of standard and custom UNIONMELT welding assemblies can easily be made to fit your particular applications—at costs lower than many current standard models.

See your local LINDE *representative today for information on the many other new features—or write for free illustrated literature.*

Linde Air Products Company
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

Offices in Other Principal Cities
In Canada: LINDE AIR PRODUCTS COMPANY
Division of Union Carbide Canada Limited, Toronto

Linde Trade-Mark

The terms "Linde" and "Unionmelt" are registered trade-marks of Union Carbide and Carbon Corporation.

—ITEM 550—

Why limit yourself to "STOCK" sizes?

Hannifin can ship the cylinder you need within 48 hours!

(NEW AND EXPANDED PRODUCTION FACILITIES MAKE THIS POSSIBLE)

Any mounting style in:

Series "A" Square Head Air Cylinders—1½" to 14" bore
Series "H" Square Head Hydraulic Cylinders—1½" to 8" bore
Series "LW" Cast Head Air Cylinders—1" to 12" bore

Strokes
As specified to 60"

Rod Ends
Catalog standards, including standard alternates.
Most special rod ends require only 24 hours longer.

Cushions
Either or both ends if required

Quantity
Normally any quantity you need for rush jobs.
For large quantities specify your requirements.

order by phone
When the need is urgent
call long distance.
Experienced sales engineers
will handle your order

CALL HANNIFIN CYLINDER SALES
Des Plaines Number—VAnderbilt 7-1171
From Chicago Phones Only—ROdney 3-4000

Do you have these two newest Hannifin catalogs?

BULLETIN 113—
Series "H"
Hydraulic Cylinders

BULLETIN 213—
Series "A"
Air Power Cylinders

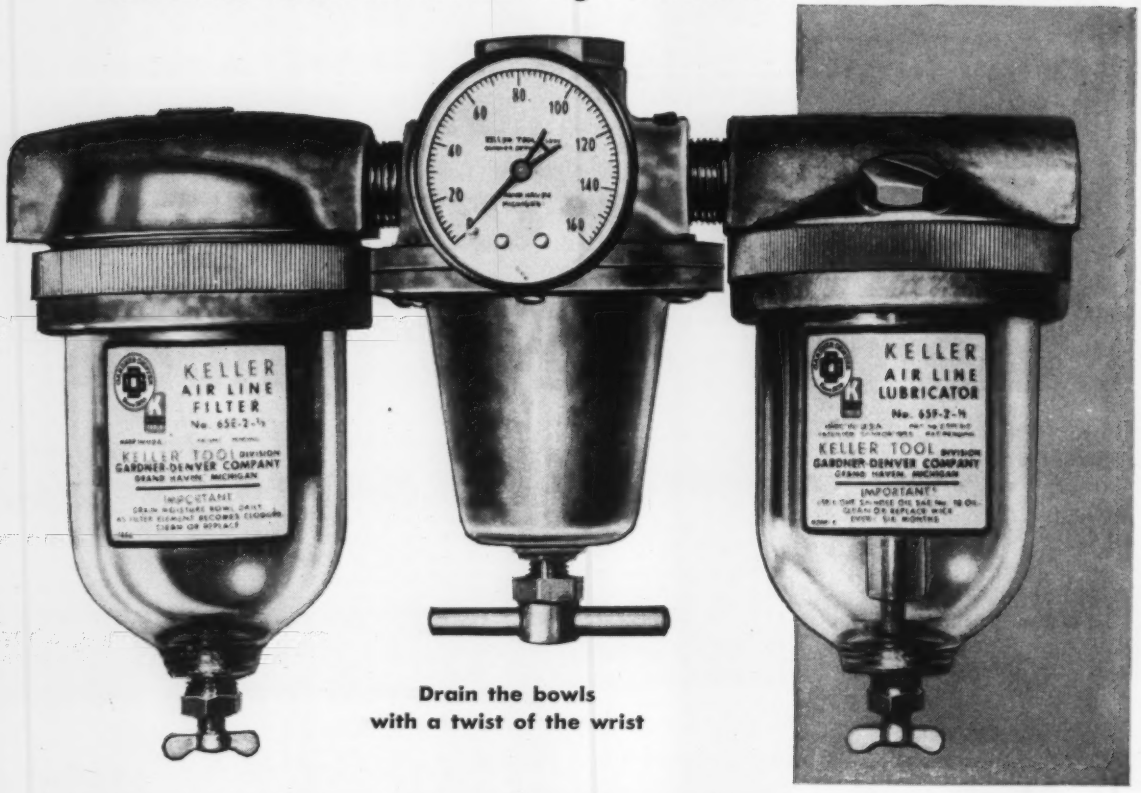
Write for your copies

HANNIFIN

Hannifin Corporation, 515 S. Wolf Road, Des Plaines, Ill.
Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves

—ITEM 551—

Gardner-Denver... Serving the World's Basic Industries



Drain the bowls with a twist of the wrist

Protect air-powered equipment with Keller air line filter-regulator-lubricator

Keller Tool again comes up with improvements. This time it's the new Keller Tool Filter-Regulator-Lubricator Combination.

NEW 1956 FEATURES . . .

- Improved regulating performance
- Unbreakable gauge face
- Inverted regulator for compact installation
- ¼" bowl drains for fast cleaning

To protect the functions of the air-powered equipment you design, specify dependable Keller Tool Filters or Regulators or Lubricators. We'll gladly send literature and specification data. Available in combination or individual units.

GARDNER - DENVER

KELLER TOOL division, Grand Haven, Michigan

THE QUALITY LEADER IN COMPRESSORS, PUMPS, ROCK DRILLS AND AIR TOOLS FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

—ITEM 552—

For More Information Circle Item Number on Yellow Card—page 19

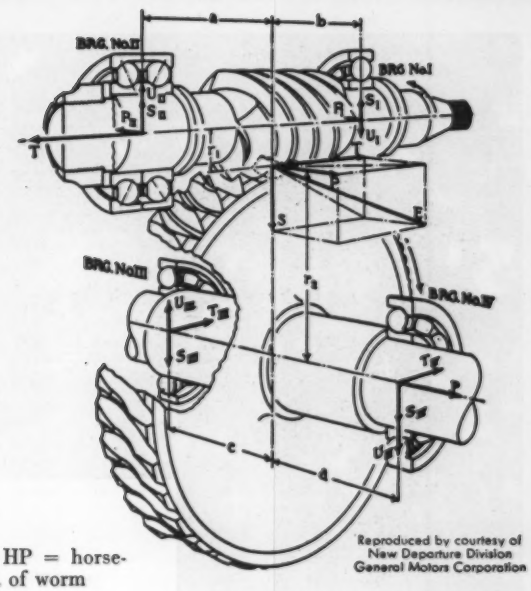
Facing Page—ITEM 553→

(Advertisement)

Helpful Data from

DE LAVAL

How to Calculate Worm Gear Bearing Loads



Reproduced by courtesy of New Departure Division General Motors Corporation

$Q = \frac{HP \times 63025}{N}$ = TORQUE INPUT to worm, lbs. inches; HP = horsepower transmitted and N = rev. per min. of worm

$P = \frac{Q}{r_1}$ = TANGENTIAL FORCE of worm, where

r_1 = Pitch radius of worm in inches

[r_2 = Pitch radius of worm gear

$= \frac{1}{2\pi}$ (number of teeth in gear x axial worm pitch)]

$S = \frac{P \tan \alpha}{\tan \gamma}$ = SEPARATING FORCE, where

α = Axial tooth pressure angle*

γ = Helix or lead angle of worm*

$= \tan^{-1} \frac{\text{lead}}{2\pi r_1}$, or $\tan^{-1} \frac{\text{Number of threads x axial worm pitch}}{2\pi r_1}$

$T = \frac{P}{\tan \gamma}$ = WORM THRUST, or tangent force driving worm gear

* LEAD ANGLE 0°-35° use 27½° Pressure Angle
LEAD ANGLE 35°-45° use 30° Pressure Angle

BEARING LOADS

Due to	on Brg. I	on Brg. II
P	$P \frac{a}{a+b} = P_I$	$P \frac{b}{a+b} = P_{II}$
S	$S \frac{a}{a+b} = S_I$	$S \frac{b}{a+b} = S_{II}$
T	$T \frac{r_1}{a+b} = U_I$	$T \frac{r_1}{a+b} = U_{II} = U_I$
Total Rad. Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{P_{II}^2 + (S_{II} + U_{II})^2} = R_{II}$
Thrust Load		T
Total Load	$\sqrt{P_I^2 + (S_I - U_I)^2}$	$\sqrt{R_{II}^2 + T^2}$

Due to	on Brg. III	on Brg. IV
P	$P \frac{r_2}{c+d} = U_{III}$	$P \frac{r_2}{c+d} = U_{IV} = U_{III}$
S	$S \frac{d}{c+d} = S_{III}$	$S \frac{c}{c+d} = S_{IV}$
T	$T \frac{d}{c+d} = T_{III}$	$T \frac{c}{c+d} = T_{IV}$
Total Rad. Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{T_{IV}^2 + (S_{IV} + U_{IV})^2} = R_{IV}$
Thrust Load		P
Total Load	$\sqrt{T_{III}^2 + (U_{III} - S_{III})^2}$	$\sqrt{R_{IV}^2 + P^2}$

Speed Change

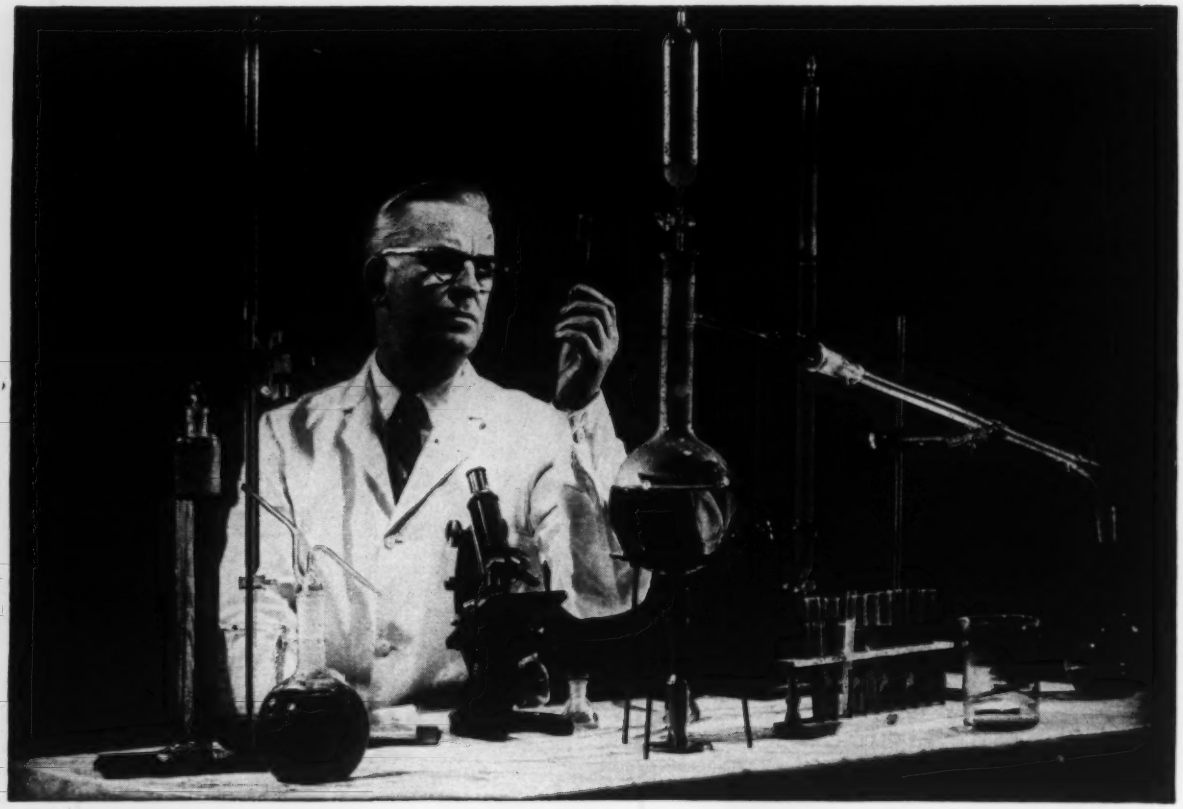
$$\text{Gear rpm} = N \times \frac{\text{Number of threads in worm}}{\text{Number of teeth in gear}}$$

For simplicity in bearing load computations for worm gearing, the normal tooth force E is treated in terms of its three perpendicular elements, namely, P, the tangential driving force at pitch radius of worm; S, the force tending to separate worm from the gear, due to the pressure angle; and T, the thrust produced by the lead or helix angle of the worm.

If you have a problem in the selection or application of worm gearing, De Laval engineers will be glad to put their experience to work for you. Either write us giving complete details, or consult your local De Laval representative. De Laval Steam Turbine Company, 858 Nottingham Way, Trenton 2, New Jersey

DL 34

XUM



Bonding rubber to nylon is one of PHOENIX' specialties

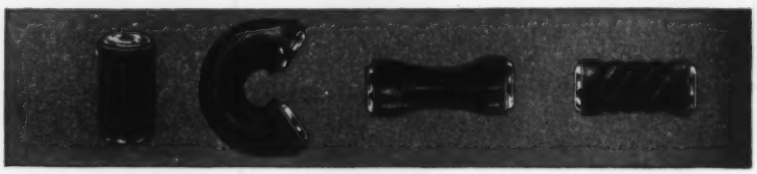
We are unusually successful at bonding natural and synthetic rubber to nylon. For example, with the flexible coupling shown below, the rubber will actually rupture before bond failure.

When you work with PHOENIX you have twenty years' experience in developmental work at your disposal. Quality control is of the utmost importance at PHOENIX. Modern laboratory facilities and exacting production control methods assure the closest of tolerances.

It is PHOENIX' practice to work in strictest confidence with our customers. Whatever rubber molding problems you may have, call on us. We are here to serve you.

Please address all inquiries to Rubber Products Division.

PUTTING THIS FLEXIBLE RUBBER-NYLON COUPLING THROUGH THE PACES. TESTING ITS "BEND," TENSILE STRENGTH AND TORQUE.



PHOENIX should be your source for custom rubber molding

PHOENIX MANUFACTURING COMPANY

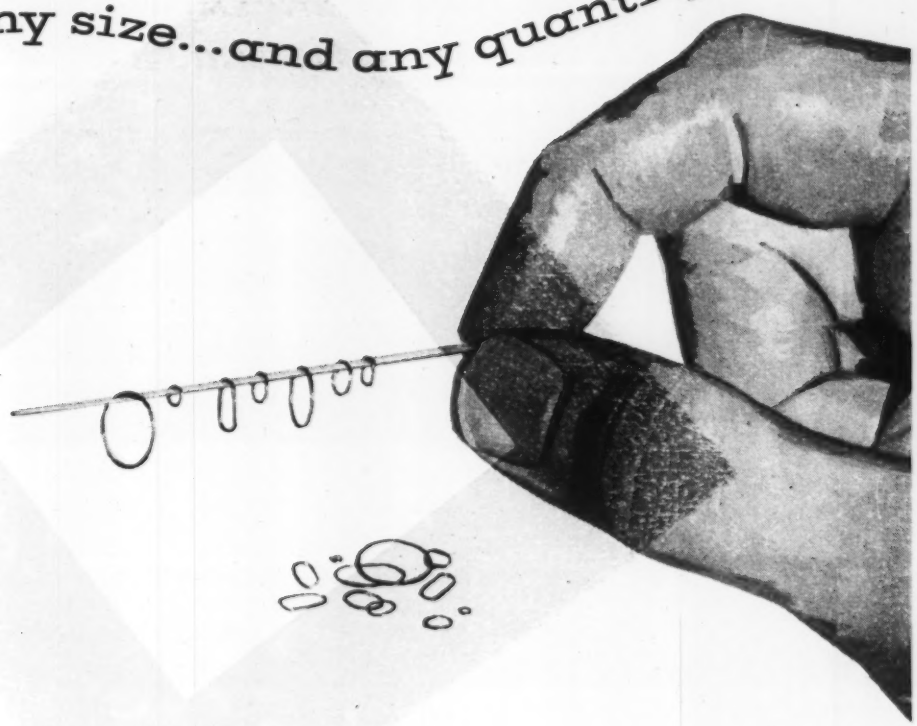
RUBBER PRODUCTS DIVISION — JOLIET, ILLINOIS

—ITEM 554—

For More Information Circle Item Number on Yellow Card—page 19

Solder Rings

-in any size...and any quantity

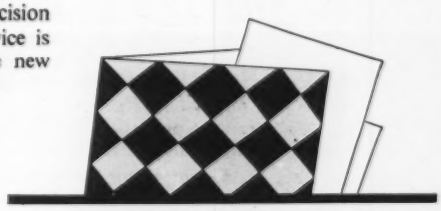


NEW from Sylvania's 4-way parts service

Now, Sylvania's 4-way parts service is ready to offer you solder rings in any size and any quantity to meet all your production needs.

New techniques, developed by Sylvania, introduce new economies and throw an entirely new light on preformed solder price and delivery. Solder rings is just one of the many services offered by Sylvania's Parts Division.

Four-slides, and special Sylvania-designed equipment can meet all your needs in wire and ribbon forms and precision small parts. Complete design service is also provided and can introduce new economies into parts procurement.



Metal Stampings is an important part of Sylvania's 4-way service to designers. For the complete story, write for the "Portfolio of 4-Way Service to Designers." Address Dept. G52S.

PARTS DIVISION

metal stamping | special wire | molded plastic | electronic parts

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N.Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

—ITEM 555—

For More Information Circle Item Number on Yellow Card—page 19

KLIXON PROTECTORS

*Safeguard Dependable Operation of General Radio Variacs**

The new General Radio Company W5MT3 Variac incorporates the latest features in continuously-adjustable autotransformers.

To keep these advanced Variacs operating dependably and give them maximum overload capacity with full safety against overheating, General Radio engineers use KLIXON Manual Reset Protectors. Here's what the Engineering Department says:

"Why KLIXON Protectors?

1. Variacs for bench use need protection from accidental overloads apt to be encountered in laboratory and experimental work.

2. The protector should trip only when the combination of overload and time produces Variac Maximum Temperature limitations. KLIXON Thermal Protectors have time-current characteristics that fit Variacs well.

3. The protector should up-rate Variac for cool operation and derate it for high ambient. KLIXON Thermal Protector does this.

4. The protector had to be as compact and inexpensive as possible in interest of space and dollar economy."

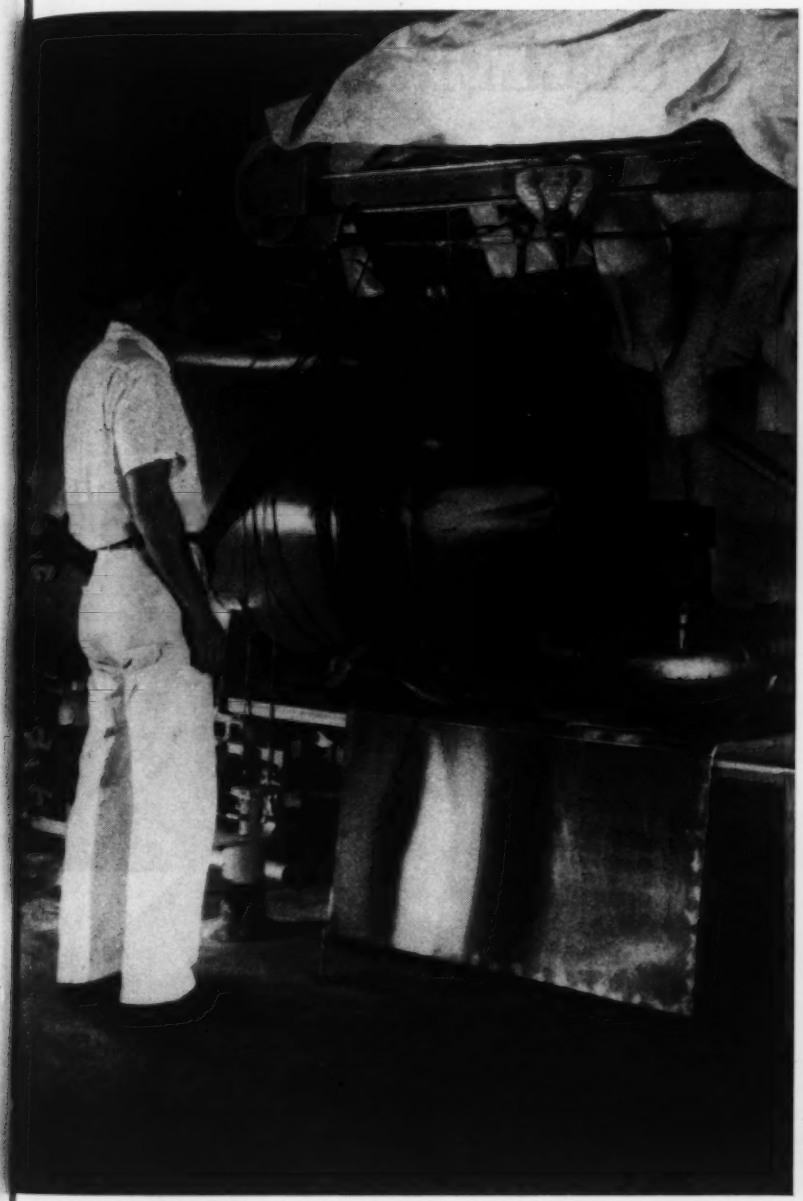
Protect your equipment such as transformers, motors, solenoids and automatic reel cords with KLIXON Protectors. They will prevent production delays, and save on costly repairs and replacements.

*General Radio Company Trademark

KLIXON®

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
3207 FOREST STREET, ATTLEBORO, MASS.

NOTHING *can equal Stainless Steel*

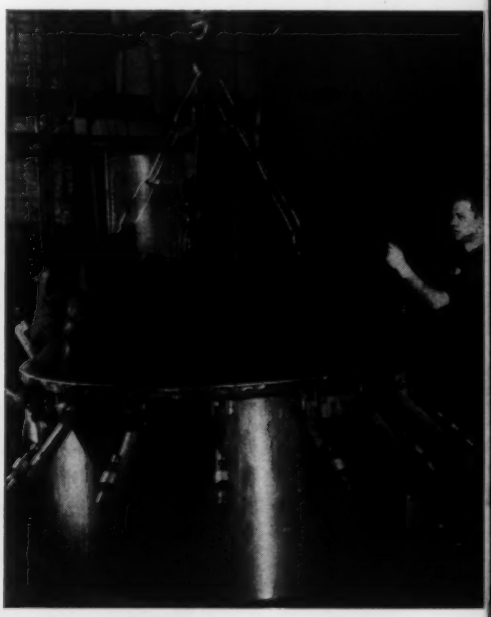


FOR CORROSION RESISTANCE. The Norwich, N. Y. plant of Norwich Pharmacal Company is a magnificent display of Stainless Steel. Shown here is a Stainless Steel filter, used to separate mother liquor from the solids of furoxone. Here, Stainless outlasts any other practical metal by two to one.

No other design material can match Stainless Steel in its *combination* of desirable properties: corrosion resistance, strength and hardness, beauty, cleanability and easy fabrication. When buying Stainless, remember that United States Steel offers the widest range of types, finishes and sizes available in the United States.

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS



FOR EASY CLEANING. In this textile plant of W. J. Dickey & Sons, Inc., dyeing time *and* costs have been cut 50% with the use of Stainless Steel equipment. When colors are changed, tanks don't have to be boiled out. With its smooth, dense surface, Stainless can be cleaned easily and quickly.

FOR CONSUMER APPEAL. Now, just about every housewife knows what Stainless Steel is. When she sees the Stainless tub in this automatic laundry, made by Speed Queen Corp., Ripon, Wis., she knows that there is nothing to corrode. She knows, too, that the Stainless tub will stay bright and clean and will last forever.

UNITED STATES STEEL

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Precision and extreme accuracy are vitally important functions of the Lensometer, manufactured by the Instrument Division of the American Optical Company, Buffalo, N. Y. The Lensometer is used to determine the focal strength and axis of an optical lens and, consequently, must be extremely precise in operation to provide accuracy and uniformity in lens prescriptions.

Forgings made by the Mueller Brass Co. play an important role in the construction of the Lensometer and contribute to its outstanding performance. Formerly, the body of the Lensometer was produced from *three* sand castings, but these now have been replaced by just *two* forgings. Naturally, this simplifies assembly, and the big forged bronze main support arm, shown above, along with the lens support bracket insures the constantly accurate alignment of the instrument. During the first year when forgings were used instead of castings, American Optical not only recovered the initial tooling costs but also realized considerable savings on each Lensometer produced. This is another good example of the way Mueller Brass Co. forgings can benefit a product two ways . . . better performance and lower costs. Chances are, your product can likewise be improved at a savings to you if you specify brass, bronze or aluminum forgings made by the Mueller Brass Co.

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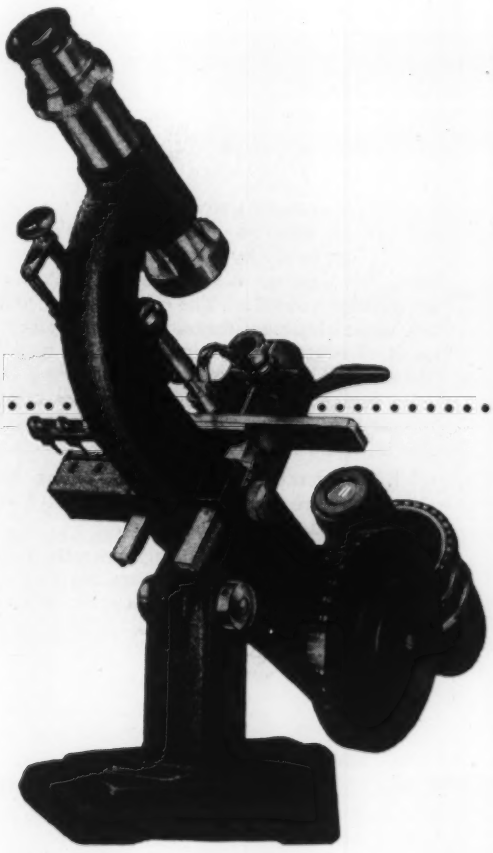

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METALS AND ALLOYS REVIEW

by FRANK M. LEVY

Vice-President and Director of Research

One of our most interesting series of alloys is the group which we market under the tradename "Tuf-Stuf" . . . a group of aluminum bronze alloys with range and flexibility to meet the most demanding needs. They are high copper base alloys containing from 9% to 13% aluminum and varying amounts of iron, nickel and manganese. Being free of zinc, they are not subject to dezincification. Tuf-Stuf alloys have a low coefficient of friction, good wearing qualities, high tensile strength, high hardness and the ability to withstand heavy pounding. Some of the alloys can be hardened by heat treatment. In the harder grades, these alloys are used for heavy duty service where high compressive loads are encountered and where lubrication may be scant. Present day increases in operating speed of modern machine equipment and the economy of little or no machine "down" time has made Tuf-Stuf popular in the machine tool industry. It is used in a multitude of applications where resistance to wear is important, such as: Drill Jigs, Feed Nuts, Rollers, Cams, Collets, Gibs, Gears, Boring Bar Guides, Lead Screw Nuts and Clutch Shifter Forks. Also, because of their ability to withstand higher stresses and resist season-cracking, these alloys are ideally suited for threaded nuts and bolts and pole-line hardware.

The unusual physical properties of the Tuf-Stuf series have made it particularly useful in the chemical and allied industries. These alloys combine the strength and ductility of medium steel with high resistance to corrosion by many chemicals. Tuf-Stuf alloys will not only resist oxidation at elevated temperatures, but will also retain a greater portion of their strength and hardness at these temperatures than will the copper zinc alloys. These properties make them ideal in the aircraft industry for valve seat inserts, spark plug bushings, valve guides and propeller hub cones.

Tuf-Stuf alloys are supplied as forgings, rod or screw machine products. As forgings the grain structure can be controlled to produce parts that are strongest at points of greatest stress and strain. Relatively intricate shapes can be forged to closer tolerances than sand castings. Where appearance is a factor, a forging may easily prove more economical since a minimum amount of machining, buffing or polishing is required before finishing.

If you'd like more information about this series of alloys, drop me a line or better yet, send me your sample part or blueprint and an explanation of its use and we'll be glad to submit our recommendations.

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178

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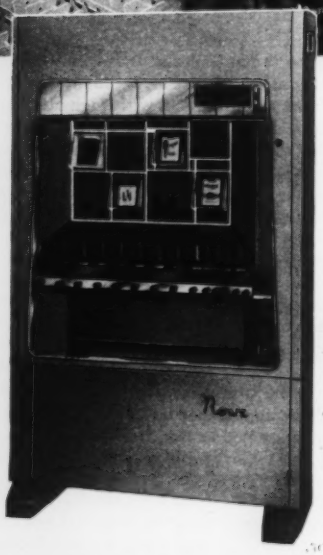

When you make a purchase from the familiar Rowe Ambassador cigarette machine, the coins are handled almost completely by a series of intricately shaped ZINC Die Castings. A die cast plunger then delivers the package you select. The efficiency with which this mechanical business transaction takes place is the result of expert engineering which has made Rowe "America's First Automatic Merchandising Family."

These are the outstanding production advantages provided by the use of ZINC Die Castings for the vital cigarette machine components:

1. Avoidance of expensive machining—the castings are virtually ready for assembly as received from the die caster.
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The continuous use of ZINC Die Castings by Rowe Manufacturing Company, Inc. through many machine design improvements, over a long period of years, is a tribute to the fine performance of such parts under rough everyday operation. For possible answers to *your* production problems through the use of ZINC Die Castings, send for our brochure and contact any commercial die casting company.

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MACHINE DESIGN
JULY 12, 1956

Making Money

A FAVORITE straw man of the pinkos and left-wingers is the cold-eyed businessman who asserts, "The only reason we're in business is to make money." It's a clever propaganda device that has had its effect in discrediting business. The deliberate distortion implied in the phrase "only reason" obscures the proper role of profit.

Legitimate business exists to perform a service or manufacture a product to fill a human need. But if it is to continue to fill that need it must make money to pay for the use of money borrowed for facilities and equipment.

Although concerned more with the product or service than with the financing of an enterprise, engineers nevertheless play a key role in determining profit.

Those who, looking at median earnings, urge higher salaries for engineers are apt to forget that fifty per cent do earn more than that median by virtue of their positive contributions toward their companies' prosperity.

On the other hand, many of the other fifty per cent, aside from juniors, may be mediocre or uninterested engineers doing little or nothing to justify any higher salary than they are receiving. Or perhaps they are sincere and hard-working but have never learned how to apply their efforts to the things that count. After all, a man can't be paid just for working hard, but only for producing a useful result.

Of course to make money is not the "only reason" a manufacturer is in business, any more than he is in business just to give employment to engineers. But the company that doesn't make money doesn't stay in business or continue to employ engineers. The engineer who has oriented himself to that hard fact has taken the first step toward deserving a salary above the median.

Colin Carmichael

EDITOR

FACTORS of SAFETY and their relation to

WHEN engineers talk about factors of safety, their associates too frequently retort, "Don't you mean factors of ignorance?" The implication is obvious: that the purpose of these factors is to cover up a lack of specific knowledge of a design by making it "twice as strong as necessary just to be sure."

Basically a concern exists that too many engineers use only one concept of factor of safety—that of applying an arbitrarily chosen reduction factor to the ultimate strength of a material to determine a design stress. Such a procedure is just "whistling in the dark" when so many variables exist. These variables, as pointed out in this article, include the exact nature of failure, the type of load imposed on the structure—steady, variable, reversed or impact—the ductility or brittleness of the material, and many other factors.

A "complete" stress analysis, if carefully carried out, would include most of the variables listed above as elements of a factor of safety. However, the big "if" here is found in the implications of the word "complete."

It is recognized, of course, that designs are often made stronger than rupture-stress requirements alone would dictate—deliberately so, because factors other than strength often determine the size of a part. For example, rigidity, stiffness, ease of fabrication and many other factors are all legitimate reasons for increasing the size of a part. These considerations, however, do not relieve the engineer from his responsibility of knowing why he has chosen the sizes and relationships in a given design. His responsibility is to formulate a good design by placing enough material at the right place. But this also means that he must not use too much material.

If handbooks and machine design texts anticipated every possible combination of loads and materials, the engineer's job would be simple. Application of basic principles to specific problems and the reaching of logical conclusions from known or assumed premises cannot, however, be completely standardized. The engineer must always interpret and interpolate for nonstandard conditions. His problem is one of determining, insofar as possible, all the circumstances involved and then designing accordingly.

Many definitions and explanations of factors of safety can be found. They range from good through indifferent to definitely poor. A poor definition is one which states nothing more or less than "the ratio of ultimate strength to design stress is the factor of safety." Somewhat better is the statement that "the ideal factor of safety indicates the margin between the actual stress—computed as accurately as possible—and the stress which will cause functional failure."

A more complete definition is found in *Handbook of Instruction for Airplane Designers* of the United States Air Force:

> The factor of safety is an arbitrary factor by which the applied loads or load factors are multiplied for the purpose of ensuring sufficient strength to permit the applied loads to be exceeded by a definite amount before complete failure of the structure occurs. In general, the factor of safety also provides sufficient strength to prevent permanent set under the applied loads. The total factor of safety may include special factors to ensure extra strength or rigidity in certain cases.

In each of these last two definitions, it is noted that "failure" is not defined in terms of actual physical fracture at the ultimate strength of the material. There is recognition that functional failure may have occurred when material stresses have reached a value that will cause permanent set in a member, or when deflections become excessive.

A better concept of the term factor of safety is that it is a measure of the margin of true safety —as closely as this is determinable—between the

stresses loads materials

By Glen H. Howell

Wayne University
Professor of Mechanical and Industrial Engineering
Detroit

stress at which "failure" is said to occur and the stress to which a part is designed. Such a definition anticipates that failure occurs in some cases when the yield stress is exceeded. In others, failure occurs when the endurance limit stress is exceeded. The important point here is the recognition of what truly constitutes failure.

Many definitions of factor of safety relate to ultimate strength. In this discussion a base factor of safety is broken into a number of separately determinable stress and material characteristic factors. The true measure of safety can be determined only after these factors are properly grouped into a composite factor, or when a base other than ultimate strength is used as a starting point.

By themselves, factors of safety are meaningless. A good design results only after all the significant load and material characteristics affecting the design are considered both individually and simultaneously. The most important of these characteristics can be grouped under five general headings to facilitate discussion: (1) failure characteristics, (2) load characteristics, (3) stress characteristics, (4) material characteristics, and (5) degree of importance of basic safety requirements.

This list is intended to be suggestive only. If carried out to its ultimate conclusion, it would encompass the entire field of stress analysis.

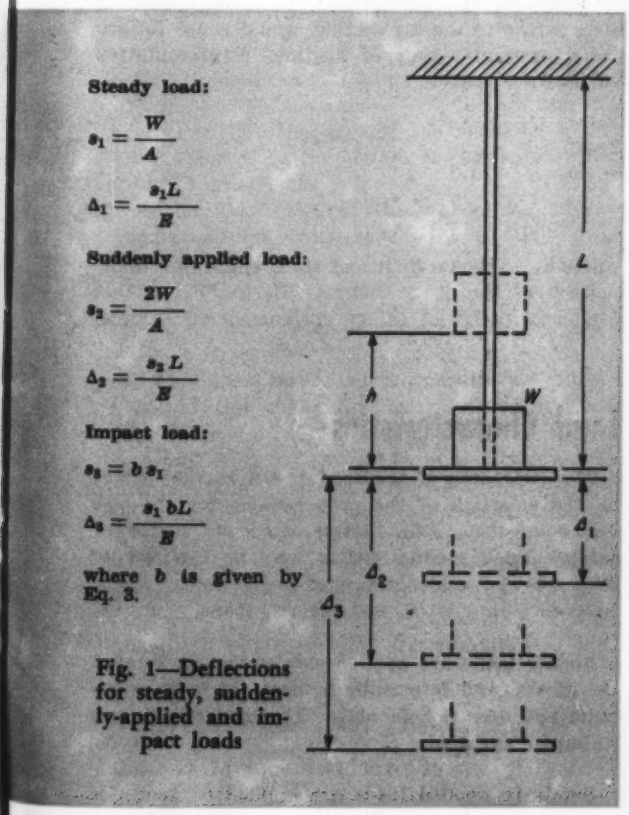


Fig. 1—Deflections for steady, suddenly-applied and impact loads

Failure Characteristics

In this category, it is necessary to examine the exact nature of "failure" in a given design. In all but a few cases "failure" has occurred long before the ultimate stress of the part is reached. Thus, the ultimate strength of the material as determined by test usually does not indicate the failing stress in a given design. More frequently, a much lower stress defines failure. In some designs, stress must be held below the elastic-limit or yield-point stress. Although the two terms are not synonymous, they are very frequently used interchangeably, and in most cases are near enough to the same stress value.

Another failure-defining point is the proportional limit, which is defined as the point where stress

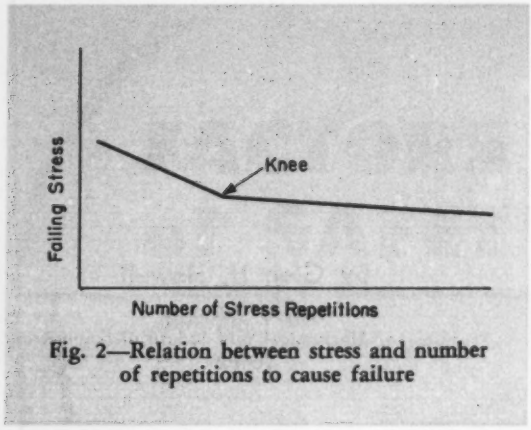


Fig. 2—Relation between stress and number of repetitions to cause failure

and strain cease to be directly proportional. Below the proportional limit, the slope of the stress-strain diagram defines the modulus of elasticity of the material. Furthermore, many of the equations used in design require that the material stresses stay below the proportional limit.

For many ductile materials, yield point, elastic limit and proportional limit are very near to the same value. This has led to the use of a composite expression—proportional elastic limit—which approximately defines all of these values.

Where complete reversal of load occurs, that is, where the stress varies from maximum in tension to maximum in compression or from maximum shear in one direction to maximum shear in the opposite direction, actual breakage may occur at a stress defined as the endurance limit. The endurance-limit stress in reversed bending is always less than the ultimate stress, and is usually less than the yield-point stress. When the yield point is less than the endurance limit, the yield point defines the limiting stress even though reversed bending occurs.

Reversed torsion produces failure at stress values less than those of reversed bending and may be the critical stress.

If partial rather than full reversal in bending or torsion occurs, some value higher than the endurance limit but lower than the ultimate stress may produce failure. The actual intermediate value should be determined before the failing characteristic is defined.

While failure characteristics are being discussed, cognizance should be given to the various theories of failure and to experimental results that justify the use of a particular theory in a particular problem. There are four generally accepted theories of failure:

1. *The maximum shear theory,* which states that failure occurs when either the direct or induced shear reaches a value of one-half the yield stress in pure tension. This theory is basically applicable to ductile materials and is based on the assumption that failing shear stress is equal to one-half the yield point in tension. This assumption is usually on the safe side for ductile material design.

2. *The maximum strain theory* holds that failure has occurred when the deformation normal to any plane equals the strain at the tensile-test yield stress. This theory finds greatest use in the design of thick cylinders for which it gives very good results.

3. *The maximum normal stress theory* contemplates failure when the normal stress on any plane reaches the tensile-test yield stress. It is used in the design of brittle materials.

4. *The strain energy theory* relates to the energy of stress times elongation and is rarely used in general design work.

Composite Factor of Safety

Most definitions state, essentially, that the factor of safety is the ratio of ultimate strength s_u to the allowable stress s_a or

$$\frac{s_u}{FS} = s_a \qquad (1)$$

When factor of safety is based on ultimate stress, it can be broken down into a number of separately determinable factors. Equation 1 can then be written as

$$\frac{s_u}{FS_1 \times FS_2 \times FS_3 \times FS_4 \times FS_5} = s_a \qquad (2)$$

where $FS_1 \times FS_2 \times FS_3 \times FS_4 \times FS_5$ equals the composite factor of safety.

In this expression FS_1 is the ratio of the ultimate stress to the stress that would cause failure for a particular type of loading. Representative values for FS_1 are

$$\frac{s_u}{s_y} = FS_1$$

or

$$\frac{s_u}{s_{er}} = FS_1$$

where s_y = elastic limit and s_{er} = endurance limit.

Each of the other factors, FS_2 to FS_5, in this composite factor of safety are considered in turn.

Load Characteristics

The character of the load has a marked effect on the selection of the proper value for the second component, FS_2, in the composite factor of safety. Load characteristics may be grouped as steady loads, suddenly applied loads, impact loads, fully reversing loads, and variable loads.

Steady loads are applied slowly enough so that the stress (and deformation) increases to its maximum and does not decrease. The load remains on its supporting member.

Suddenly applied loads are applied without ini-

tial velocity, but in such a fashion that the stress (and deformation) increases to a maximum value of twice the stress developed when the same loads are applied slowly. This is diagrammatically illustrated in *Fig.* 1.

After some oscillation the stress (and deformation) will become the same as if the load were applied slowly. However, in most designs the maximum stress will be the determinant.

Impact loads differ from suddenly applied loads in that impact loads will strike the supporting member with an initial velocity which, in *Fig.* 1, will be a function of the distance h through which the load falls.

For the assumption of fully rigid supports (this is on the safe side) the equation for stress in the rod of *Fig.* 1 due to impact is:[1]

$$s_i = \frac{W}{A}\left(1 + \sqrt{1 + \frac{2h}{\Delta_1}}\right) =$$

$$s\left(1 + \sqrt{1 + \frac{2h}{\Delta_1}}\right) = sb \quad \ldots\ldots\ldots\ldots\ldots (3)$$

where s_i = stress produced, psi; W = applied load, lb; A = area, sq in.; h = height of free fall to produce velocity of impact, in.; Δ_1 = deformation produced by load W under static conditions, in.; $s = W/A$ = static stress, psi. The constant b is

$$b = \left(1 + \sqrt{1 + \frac{2h}{\Delta_1}}\right)$$

Deflection due to impact is

$$\Delta_3 = \frac{s_i L}{E} = \frac{sbL}{E} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Two things can be observed from Equation 3: (1) the greater the value of Δ_1, the less the effect of h, and (2) the greater the value of h for a given value of Δ_1, the greater the stress, and therefore the greater the value of Δ_3.

As an illustration of the multiplying effect of impact load on stress, assume Δ_1 = 0.001-in. and h = 0.0075-in. Then

$$b = 1 + \sqrt{1 + \frac{2(0.0075)}{0.001}} = 5$$

and the impact stress is five times the static stress.

All of the above illustrates the necessity for taking account of the characteristic of the load in establishing values for factors of safety. This characteristic is represented by FS_2 in Equation 2. In a design where suddenness of load application or impact occurs, this factor may be large. However, design changes can be made to reduce the numerical value of the factor. It may be possible, for example, to increase the value of Δ_1 in Equation 3 without decreasing the effectiveness of the design in any way.

Fully reversing loads cause the stress in a particular part to vary from maximum in tension to maximum in compression. Where such a full reversal occurs, as for example, in a rotating shaft under a bending load, failure will occur at the endurance-limit stress. Experiments indicate that the relationship between failing stress and the number of stress reversals takes the general form shown in *Fig.* 2.

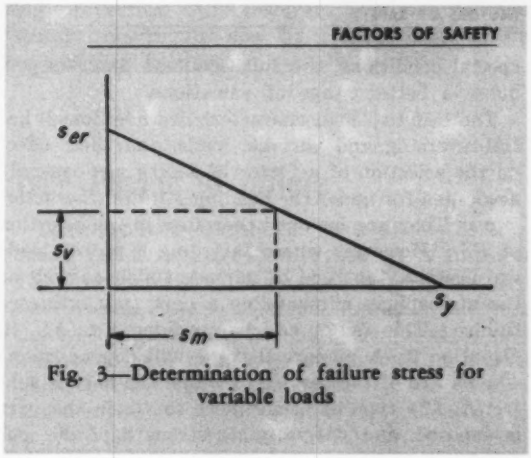


Fig. 3—Determination of failure stress for variable loads

Usually, the assumption is made that, if the "knee" in *Fig.* 2 occurs at more than 100 million reversals, the failing stress at that figure can be used as the endurance limit. At this stress it is assumed that failure will not occur after an infinite number of reversals. Some aluminum alloys do not show a "knee" up to 500 million reversals, and tabulations of endurance limits for aluminum alloys are sometimes based on this value.

Although s-N data for fully reversed shear limits are not as readily available as for tensile and compressive loads, the shear endurance limit is frequently assumed to be 55 per cent of the endurance limit in tension.

Variable loads may exist where the load is neither steady nor full reversing. The load may change from zero to a maximum in either compression or tension; it may change from a high tension to a relatively lower tension; or it may alternate between two numerically different values of tension and compression. Where such load conditions exist, a single stress factor will not suffice. A method must be used which, in effect, determines what variable stress is superimposed on the applicable mean stress. From these values it is possible to determine a reasonable failing stress for the particular load conditions involved. A simple manner in which this can be done for many cases is shown in *Fig.* 3, which is a modification of Goodman's diagram.[2]

In *Fig.* 3, s_{er} is the endurance limit in reversed bending and s_y is the yield point of the material. If the abscissa s_m represents the mean stress, then s_v represents the variable stress that can be imposed up to the point of failure. Also the sum of $s_v + s_m$ or s_t is the total stress that produces failure. For

[1]References are tabulated at end of article.

special conditions, the full Goodman diagram produces a better range of variations.

The last two load characteristics mentioned, i.e., full-reversing and variable loads, and their effect on the selection of a factor of safety are basically accounted for under the heading *Failure Characteristics*. They are included therefore in the selection of FS_1. However, where fatiguing types of loads are present, the type of surface finish as well as the atmosphere surrounding a part may influence failure.[4] This factor can be considered as FS_3 in Equation 2. A numerical value will depend upon: (1) nature of the service to which the part is subjected, (2) type of atmosphere to which the part is exposed, and (3) ultimate strength of the material.[3]

Stress Characteristics

Although a complete discussion of stress and the many methods for calculating it for special cases cannot be included here, a few comments are pertinent.

One fact concerning stress is particularly important. The stress present in a body (within the proportional limit) is not a function of the material. It is a function of the distribution of external loads and the geometry of the part. For example, $s = Mc/I$ defines the stress in bending whatever the material in the beam. If, however, it is desired to know if the beam design is satisfactory, the calculated stress from the beam equation must be compared to the allowable stress for the material being considered. Such a distinction of terminology appears academic, but it is actually fundamental.

In addition to the direct stresses that must be considered, it is also necessary to determine the effect of induced stresses. Superposition of direct and induced stresses may be possible where the stresses act on the same plane. This question also leads to consideration of the combined effects of both shear and normal stresses on a plane, and the determination of the combined stress effect. The following equations indicate the procedure for calculating combined stresses:

$$s_{s,max} = \frac{1}{2}\sqrt{s_t^2 + 4\,s_s^2}$$

$$s_{t,max} = \frac{1}{2}\left(s_t + \sqrt{s_t^2 + 4\,s_s^2}\right)$$

where $s_{s,max}$ = shear stress resulting from tensile and shear loads; s_t = tensile (or normal) stress; s_s = shear stress; $s_{t,max}$ = tensile (or normal) stress resulting from tensile and shear loads.

Much work has been done in those areas where the simple stress equations, $s = P/A$, will not give satisfactory results. To illustrate, if a bar subjected to tension has a hole in it, *Fig.* 4, the stress at a cross section through the hole as calculated by elementary theory is

$$s = \frac{P}{t(w - d)}$$

The actual stress is greater by a factor known as the "stress concentration factor" K or

$$s = \frac{KP}{t(w - d)}$$

where K is experimentally determined.

Curves of values for various types of stress

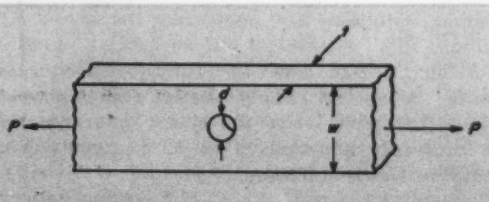
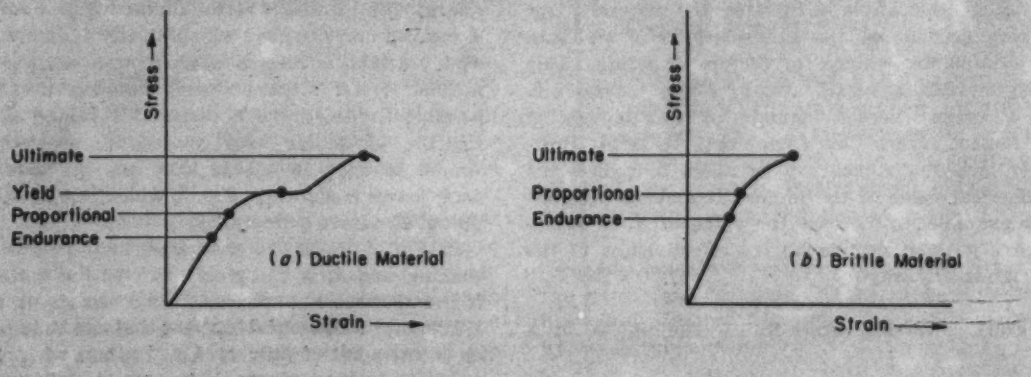


Fig. 4—Bar with hole under tension load

Fig. 5—Typical stress-strain diagrams for ductile and brittle materials



raisers are available.[4] Stress-concentration factors determined from such sources of information are the basis for determining FS_4 in Equation 2.

Material Characteristics

Material characteristics influence the design of a part very markedly. Ductile materials, for example, are usually assumed to fail according to the maximum shear theory. On the other hand, brittle materials usually are better designed on the basis of the maximum normal stress theory. In either case, cognizance must be given to homogeneity factors, uniformity of test and product samples, reliability of available data, etc.

Perhaps a look at the stress-strain diagrams for brittle and ductile materials will be of further help in deciding upon design factors. Typical stress-strain diagrams and critical stress lines are plotted in *Fig.* 5.

In a preceding discussion, it was pointed out that the designer, in most cases, will keep the total stresses as close below the elastic limit as is feasible. The stress diagrams for brittle and ductile materials illustrate to a limited degree not only where the stress limitation is, but also why it differs with materials of different characteristics. Curves of various materials will have varying properties. All, however, have one common factor: they require specific study to establish the area of their best use.

True Factor of Safety

The only true measure of "safety" in the compound factor of safety (Equation 2) is found in FS_5. In choosing this value, the engineer must consider overall cost, possible indeterminate load variability, overstressing for code compliances, possibility of human injury, lost production due to machine down time, maintenance and service costs and many other factors. Here he makes a real decision based on his experience and judgment.

Furthermore, either implicitly or explicitly, the engineer must determine which of the five parts of the composite factor of safety are related to his particular problem, and either use or discard them as the design requirements dictate. All the factors are not applicable to every design.

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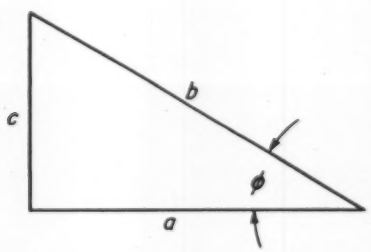
2. Reference 1, Page 76.
3. P. H. Black—*Machine Design*, McGraw Hill Book Co. Inc., New York, 1955, Page 39.
4. R. E. Peterson—*Stress Concentration Design Factors*, John Wiley & Sons Inc., New York, 1953.

Tips and Techniques

Drawing Angles Without a Protractor

WHEN a protractor is not available, the principle of right-angle triangulation may be used in laying out angles. If two sides are known, the third side may be drawn in to construct the angle.

In the accompanying table, one side has been chosen to be 2 or 3 in. The second side is computed from trigonometry tables. Only a few representative angles are listed in the table; many others may be added if desired. The error introduced by reducing the length of the sides into increments no smaller than 1/64-in. is negligible.—D. E. SWEET, *Marblehead, Mass.*



Angle (degrees)	Side a (in.)	Side b (in.)	Side c (in.)	Error (minutes)
5	2	..	11/32	4
10	3	..	13/32	2¼
15	2	..	13/32	7½
20	..	2	16/32	6
25	..	2	15/32	3
30	..	2	1	none
35	2	..	1 19/32	6½
40	2	..	1 17/32	2½
45	2	..	2	none

Remembering Trigonometric Functions

Remembering trigonometric functions can be facilitated by memorizing the short phrase: **O**scar **H**as **A** **H**ouseful **O**f **A**pples. The first letters of each word represent a side of the triangle. That is, **O** is the opposite side, **H** is the hypotenuse, and **A** is the adjacent side.

From the phrase, the sine of the angle is represented by the first letters of the first two words, the first being the numerator, the second the denominator. Then sine = **O/H**. Similarly, cosine = **A/H** and tangent = **O/A**.—DONALD R. FABA, *Mattydale, N. Y.*

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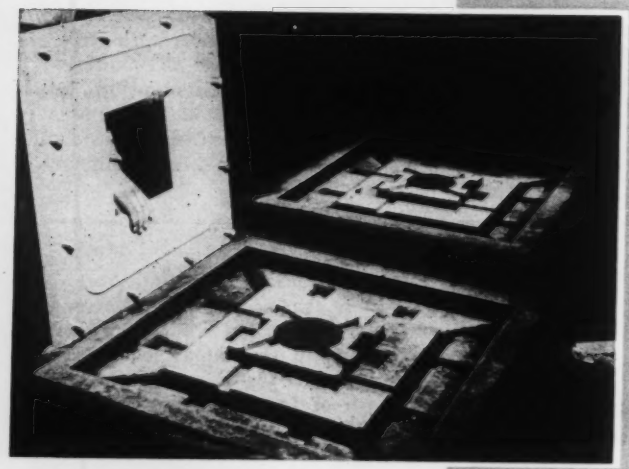
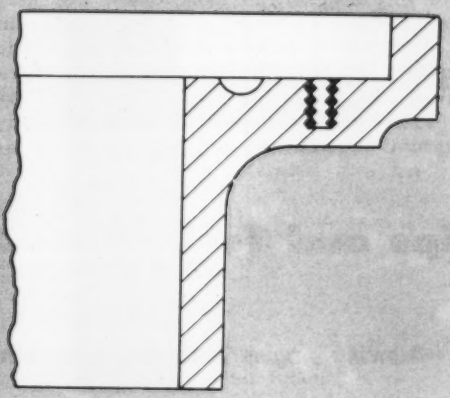
XUM

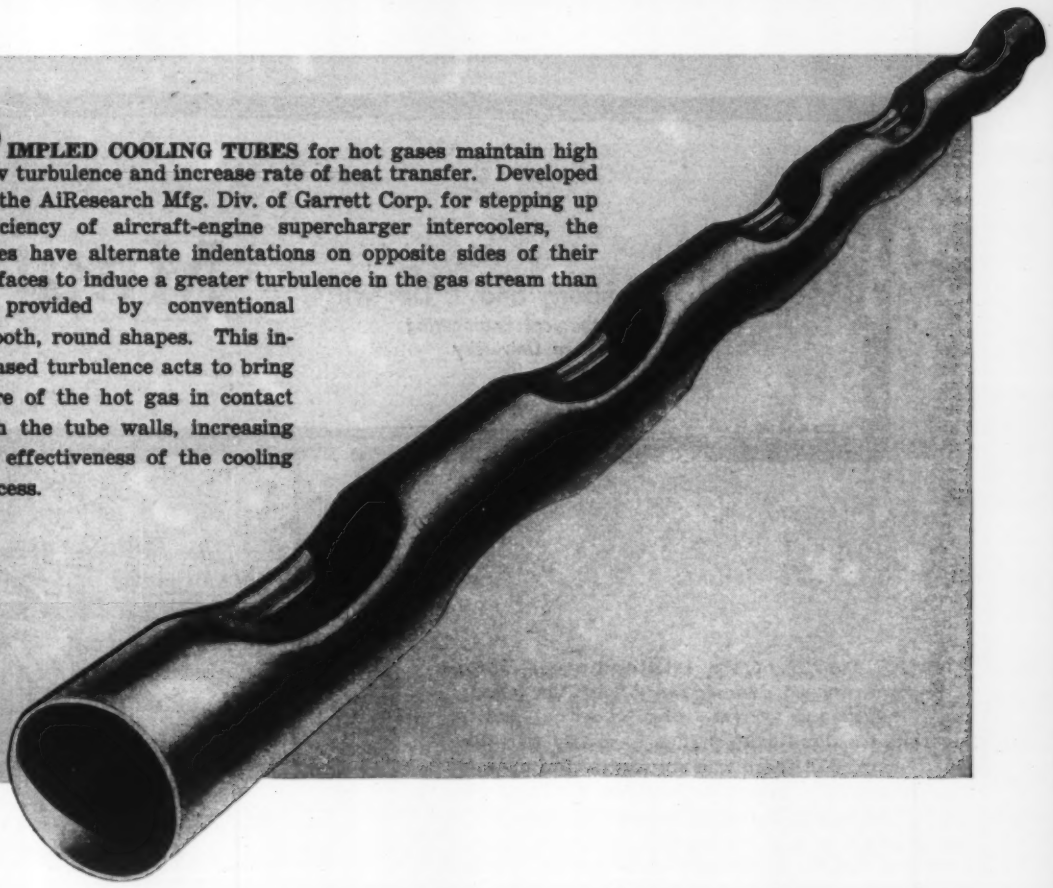
scanning the field for *Ideas*





CAST-IN THREADS of stainless steel eliminate conventional drilling and tapping operations in cast-iron parts. In a method developed by Francis Le Baron of E. L. Le Baron Foundry Co., special close-wound Heli-Coil stainless-steel wire thread inserts are cast directly into gray iron. Properly positioned and anchored in the mold on sand cores, the inserts permit the hot metal to flow around their exteriors forming a secure bond. Standard blast-cleaning equipment removes the cores from inside the inserts, leaving strong permanent threads of stainless steel.

DIMPLED COOLING TUBES for hot gases maintain high flow turbulence and increase rate of heat transfer. Developed by the AiResearch Mfg. Div. of Garrett Corp. for stepping up efficiency of aircraft-engine supercharger intercoolers, the tubes have alternate indentations on opposite sides of their surfaces to induce a greater turbulence in the gas stream than is provided by conventional smooth, round shapes. This increased turbulence acts to bring more of the hot gas in contact with the tube walls, increasing the effectiveness of the cooling process.



TWO-PIECE IMPELLER design facilitates assembly and disassembly of blades through small access openings. Used in Pfaudler separable-blade agitators for reaction kettles, the design eliminates the need for large openings required with conventional fixed impellers and helps prevent possible damage to interior surfaces or components during assembly. The impeller, which consists of a single and a double blade, is mounted to the shaft inside the operating chamber after the drive unit has been installed.

XUM

Men and

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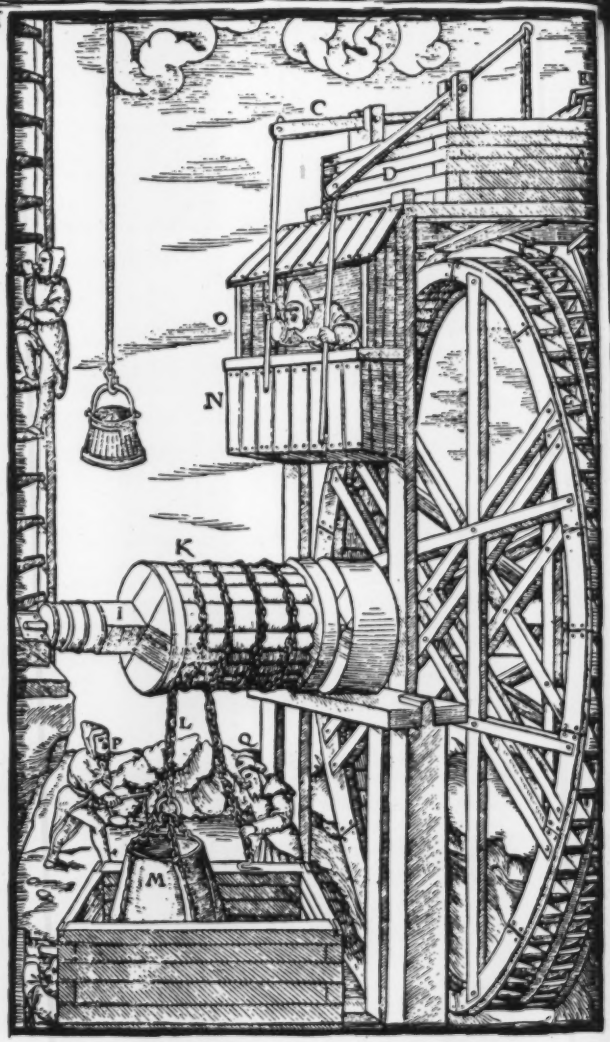
THE DAWN of the 18th century in Europe was indeed dismal, for it saw the peasant, smith and weaver using tools that had undergone no significant change in nearly two thousand years. Yet there was an unrest. For example, the demand for textiles had caused the hand spinning wheels and looms to increase in size to the point where it was no longer feasible to use low-powered and low-speed sources of energy. Cottage industries could no longer cope with the demand. The increasing demand for iron in rolled shapes and plate form required more than animal or water power to meet the need. Mines were getting deeper and hence harder to unwater; the cumbersome animal-powered pumps and windlasses were not up to their tasks. Water and wind power were only where they were found — not necessarily where they were needed.

In the attempt to meet the demands for more and cheaper goods, basic machines were compounded and combined to form more complex elements, and the whole was brought to a central location. The operation of large machine units, bigger and deeper-reaching mine pumps, water supplies for growing populations—these and many other problems came to sharp focus almost simultaneously. Power in large pieces was needed to cope with the situation. The major sources of energy in the 18th century were then, as now, two—power from water and power stored in chemical substances. Water power[1] can be exploited in a large way only if it is converted into electrical energy suitable for transmission, a 20th century development. Chemical energy, as food, can be converted only ineffectively and applied in small quantities as



A—Reservoir. B—Race. C, D—Levers. E, F—Troughs under the water gates. G, H—Double rows of buckets. I—Axle. K—Larger drum. L—Drawing-chain. M—Bag. N—Hanging cage. O—Man who directs the machine. P, Q—Men emptying bags.

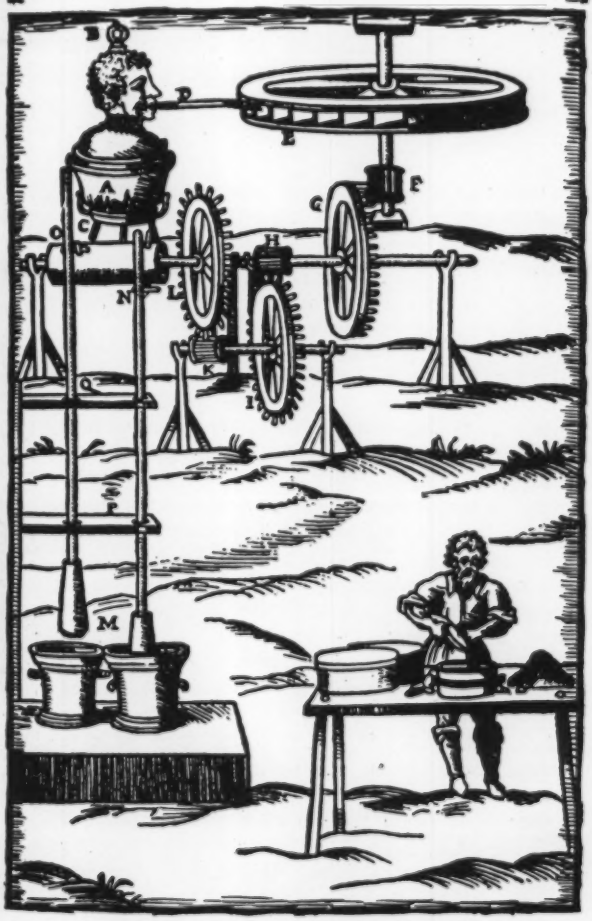
"Winding machine" of 1556, power driven for both hoisting and lowering, the friction of the machinery being so great that for lowering gravity needed to be augmented. This use of two wheels for changing shaft rotation is still current practice in marine power plants. (From Agricola, Hoover translation)

[1]The old-time water wheel is not completely a museum piece in the western world. The modern version, often of steel, is still working patiently with trivial attention here and there where power demands are modest. See "There'll Always be Water Wheels" by Neil M. Clark, in the *Saturday Evening Post* of December 3, 1955. "Dozens of mills are using water wheels . . . to do a business of a million or more a year." The many applications include hundreds on farms.

*Now, French Air Force.

Machines ... an informal history

This is the last installment of an investigation into the origins of machines in relation to the affairs of people and nations. Earlier chapters appeared in the issues of May 3 and June 14, 1956.



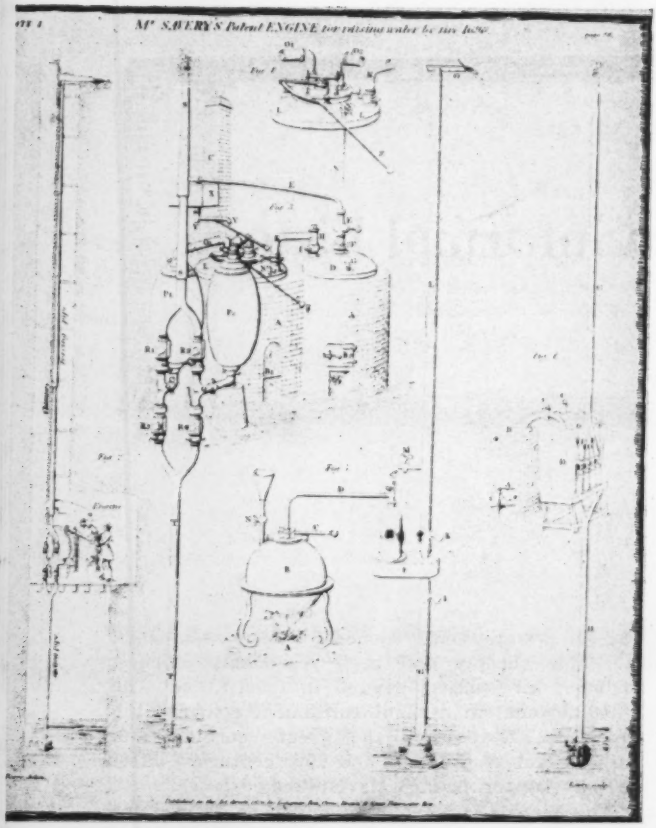
Branca's proposal for a stamp mill drive, 17th century. (From Diels)

muscle power. Until chemical energy was made available cheaply and in a reasonably efficient manner, all industry lagged in frustration. The human wants in need of fulfillment spawned the Industrial Revolution, the great economic and social event of the 18th and 19th centuries, offset in part by the French Revolution.

The Industrial Revolution might be defined for our purposes as that time when the use of coal or chemical energy came to drive engines equivalent to hundreds of horses, allowing power-driven machinery to replace the handcrafts and to usher in the Machine Age. It started, roughly, with the building of the first practical and accepted steam engine of Newcomen in 1712. This engine, the fore-runner of all engines based on heat power, really provided a revolution in energy conversion.[1] All motor systems, animal or mechanical, have in common the fact that they use the stored energy of chemical substances and liberate it by chemical action. The animal muscle gives a direct transformation of this chemical energy into mechanical power. The nonliving device makes a primary conversion to heat — the intermediary is always a fluid at high temperature—which must then be further exploited to yield power at the end of a shaft.

The Industrial Revolution was centered in those few areas where cheap coal was available. It was thus an actuality in but a small part of Britain. It was impossible to transport by road bulky materials such as ore and coal because of the abominable condition of the 18th-century roads (even with today's roads it still remains the most expensive way). Canals, necessarily limited by

[1]A recognition of the fundamental nature of the innovation known as the Industrial Revolution would be to call it the Revolution in Chemical Energy. It was the more efficient conversion of chemical energy into mechanical energy that made possible all the developments that followed. Indeed, this process has just repeated itself with the knowledge that has brought atomic energy into man's sphere. We cannot very well change the old terminology, but we should recognize things for what they really are—not be blinded by the mechanism and lose sight of the principle.



The Savery engine to raise water by the direct condensation of steam in the suction pipe. (From Farey)

geographical features, were highly developed in the 18th century, but served only certain fortunate areas.

From Britain the Industrial Revolution spread slowly. Its products moved into the world at great speed, for Britain, drawing most of the raw materials from her colonies, processed them into merchantable goods and became the tradesman of the world. Rivals to Britain were for a long time confined to other coal areas—notably in the Ruhr and Pennsylvania.

THE present Machine Age is derived from the Industrial Revolution through the medium of the steam engine. Since the history of the growth of the latter-day mechanic arts is the story of the engines and the machines they drove, the essential parts of the story of steam and its piston engines must be told.

Steam was first used to produce a rotary motion, as in the aeolipiles described by Hero of Alexandria, just after the beginning of the Christian era. The aeolipile was a spherical vessel used for generating steam. When it was pivoted on, say, a horizontal axis, and fitted with two bent nozzles with oppositely directed tangential openings in the vertical diametral plane, the vessel was spun around by the reaction of the escaping steam. In modified form, aeolipiles were used in the 17th century to replace bellows for smelting ores and working glass. The inversion of this machine, in which a jet of steam was allowed to play on a toothed or vaned wheel, was suggested by Branca in 1629. It was the remote ancestor of the turbine.

The piston and cylinder appear for first mention in the *Pneumatica* by Hero of Alexandria, who reports on what had gone before as well as what he himself did, without, however, being too clear about who did what. At any rate, he describes a two-cylinder single-acting force pump, with the pistons connected by a walking beam to give a practically continuous stream: this was a firepump, manually operated. The manual force pump probably reached its peak of development in the fire brigades of not too long ago, where 25 to 30 men on a side operated the pumps. With 60 men, each producing under stress say about a quarter horsepower, perhaps fifteen horsepower were developed. The London Bridge Water Works, installed in 1581, were described in the *Philosophical Transactions* in 1781, and while it is not clear as to just what period the figures apply, a 20-ft diameter waterwheel turned cranks and rods operating the piston pumps of 7-in. diameter in a cylinder that was 4 ft 9 in. long.

The piston vacuum pump was used by Otto von Guericke of Magdeburg in 1650 in connection with his demonstrations on vacua. The plunger type of pump is ascribed to Sir Samuel Moreland in 1675. It took a long time for the working surface of the piston to move to the rod side, perhaps because of stuffing-box difficulties.

Continuing experiments with the aeolipile led inevitably to the discovery of the pressure decrease following the condensation of steam in a closed container. This property seems to have been first applied to raising water. The upper end of a pipe dipping into water was filled with steam, the steam valve closed; as the steam condensed, atmospheric pressure forced the water up the pipe. Thomas Savery patented the first mine pump of this type in 1698, although it had the same principle as that patented in 1628 by the Marquis of Worcester. There was, of course, a great deal of initial and uncontrolled condensation since the steam was in direct contact with the water.

Denis Papin,[1] a Frenchman who was professor of mathematics at the University of Marburg (Germany), made use of the pressure drop of condensing steam to let atmospheric pressure force a piston *into* a cylinder; a chain or cable fastened to the piston could then exert a pull. Papin had elaborate plans for his engine, but they all came to naught. However, the "atmospheric engine",

[1]Papin (1647-1712) was a man whose talents exceeded their acceptance. Although a member of the Royal Society, he died in want in London. Among his practical inventions were the pressure-cooker and the lever safety valve.

which was to dominate the scene for many years, had been created. It was single-acting, and the condensation was hurried by injecting a spray of water directly into the cylinder. The steam boiler was more or less spherical resembling the aeolipile from which it was descended.

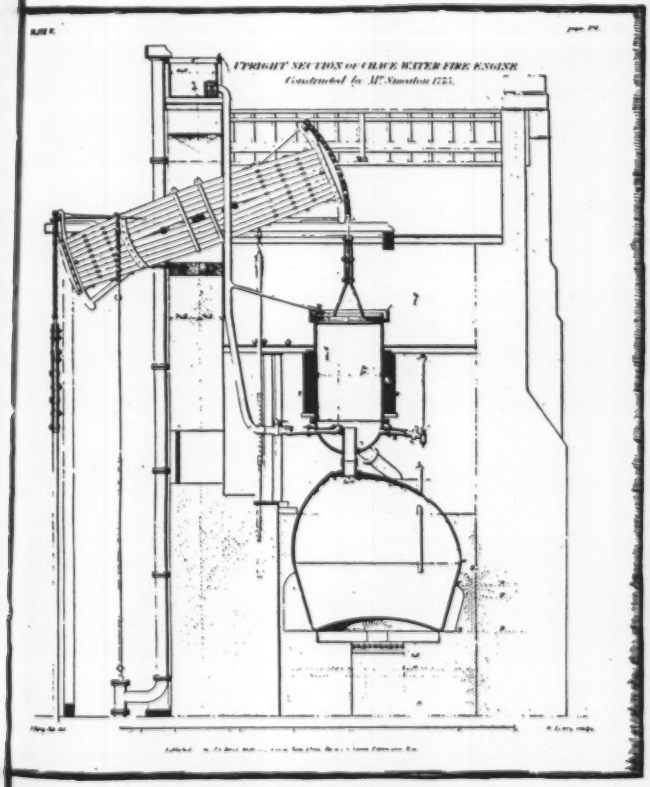
Thomas Newcomen adapted the atmospheric engine as a pumping engine in 1712. The steam and pump cylinders were vertical, and some distance apart, each piston being connected by means of a chain to its end of an overhead oscillating beam—"the great beam"—supported midway between the cylinders. These engine-pumps were used to drain wet lands, act as town water suppliers, raise water to drive mill water wheels, and unwater mines.

The mines of Cornwall were deep and the coal was poor, but the Newcomen or atmospheric pumping engine was a welcome replacement for the muscle-powered pumps. Water came into the mines 'round the clock, without regard for the worker's shifts or animal weariness. Relays of horses were needed to keep the shafts accessible. Space required for a horse and his machinery was sizable, and the animals had to be sheltered during their off-hours. A single engine could do the work of several hundred horses at a fraction of the cost of the live horsepower. For example, an engine to be installed in Warwickshire replaced 500 horses whose annual expense was £900; it cost but £150 to operate the engine. Furthermore, the engine could run all day and night, and when shut down was without operating cost. Engines were rated on their "duty"—duty was the amount of work done by a given quantity of fuel.[1] If they were compared with horses, then the duty was reckoned on the cost of the feed, i.e., the fuel.

With power available on only the down-stroke, the engine was obviously unsuited to produce rotary motion, but it served the mine-pumps well. It produced cheap power in relatively large units for the time. Of low efficiency, and burning the lowest grade of coal, atmospheric engines were slowly improved by Smeaton[2] and others, and some

1—as "2,919,017 lb of water raised one foot per 84-lb bushel of coals."

2John Smeaton (1724-1792), Fellow of the Royal Society, was a distinguished civil (as different from military) engineer who, in addition to refining the Newcomen engine, prepared designs of canals, harbors, bridges and the like. He rebuilt the Eddystone lighthouse in 1759, and in that year developed a conservative formula for wind-pressure on structural surfaces that was regarded as a standard in engineering texts for many years.



An improved Newcomen type engine built by Smeaton. A "water fire engine" is merely a steam-driven pump. (From Farey)

A gearless "hand-operated mill" of 1661. The weights *F* have been added to increase the inertia of the flywheel. The bar carrying *C* agitates the chute (not clearly shown) through which the meal is delivered. (From Boeckler)

were in use until about 1830. The engines were bulky and slow. Cylinder diameters were 30, 50 and even 72 in., the stroke 6 to 8 ft, the effective pressure about 8 psi, the speed 16 to 25 strokes per minute. It has been estimated that 75 hp was perhaps the maximum ever developed.

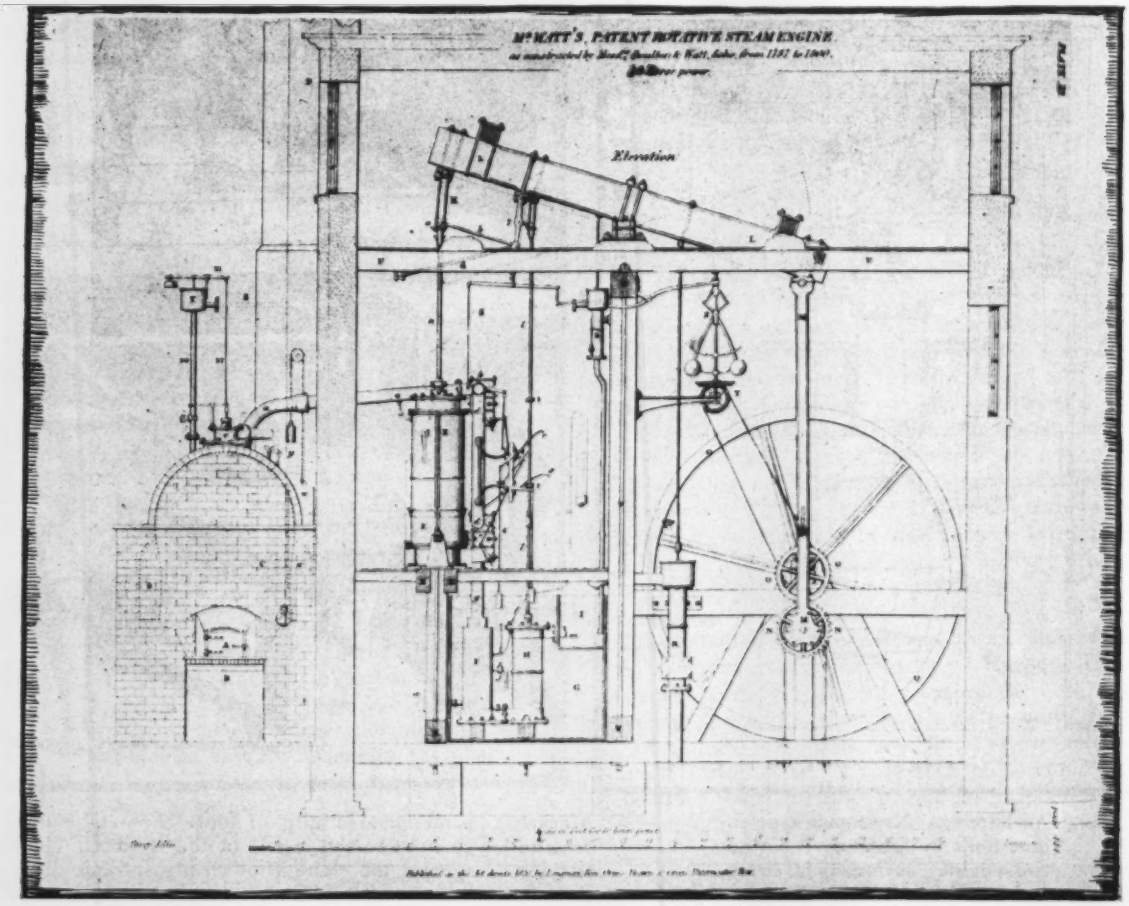
TODAY we speak lightly of horsepower, for nearly every car on the highway has a potential of more than a hundred of the ideal horses, and the average home may have appliances with a total of 3 to 5 hp. It may be interesting to consider again the power of a man and the economic implications. An average (an ideal of sorts!) man can produce about 1/10 hp while working at a rate that will not exhaust him. This "power-plant" weighs perhaps 200 pounds; the figure includes the weight of the man as well as that part of the apparatus, as crank and shaft or treadmill or capstan, that is converting his effort into a useful mechanical motion. At this rate, it would take ten men to develop 1 hp, providing they didn't get into each other's way. Thus the man-horsepower weighs something like 2000 pounds, or about as much as a very big horse. Today's modern aircraft piston engine develops 1 hp for appreciably less than 1 pound of weight.

With the employment of slave labor, the food costs were equivalent to the fuel costs, and this sort of power was then more or less competitive with the horse on a pound-for-pound basis. If, however, freedmen drawing wages were employed, then it became cheaper to use the horse. On the other hand, it was impractical to couple too many horses because of the confusion (beyond seventy or eighty horses the situation was said to get out of hand!).

The Newcomen engines,[1] improved in detail but not in principle during the next decades, remained in sole command of the mine pumps until the Watt engine with its vastly superior efficiency appeared in 1777. After this, the atmospheric engines were gradually supplanted, although as noted before, some were kept in service for years beyond this

[1]The details of the colliery engine at Ashton Vale, installed about 1750, are of interest. The bore was 5 ft 6 in., the stroke 8 ft, with 10-11 strokes per minute. The cylinder working pressure ranged between 2½ psi to a 9-10 psi vacuum. Three 9¾ in. diameter bucket pumps had a lift of 750 ft. The estimated horsepower was 52.

A Watt engine, showing the sun-and-planet drive and Watt straight-line motion. (From Farey)



time, for they were heavily built, simple in construction, and easy to repair on the spot by the engine men.

James Watt, skilled mechanic and instrument maker, made significant improvements based on a scientific perception of the properties of steam. Whereas the older engines had been merely "built," it may be said that Watt's were designed from critical considerations. Indeed, the "invention" of the modern steam engine is often ascribed to Watt, so significant were his modifications and additions to the Newcomen engine. The radical improvements included first of all the use of an external condenser, thus allowing the cylinder to stay hot (further exploited by the introduction of insulation and steam-jacketing), and the earliest recognition of the expansive power of steam. Watt was granted a patent in 1769, although the first engine was not built until 1774 because of financial troubles. With a duty double that of the best improved Newcomen type engine, the Watt engine was very attractive in even the land of cheap coal. In 1777 the interest of the mine owners in Cornwall was realized by an order for an engine. During the next ten years most of the Watt engines were absorbed by that County as either replacements or new installations.

The canny Cornish miners were reluctant to buy Watt's pumping engines outright; he had to put them into operation on a royalty basis. The annual rent was one-third of the saving in fuel cost for the same duty. Initially this was a favorable arrangement for the mine owners, although they complained loudly and in court, when, with the inevitable improvements, the engines required only a quarter of the fuel of an atmospheric engine having the same duty. Watt was led to establish the power of an ideal horse as a basis for engine-rating. This technical and economic reason for the origin of the horsepower unit is generally forgotten.

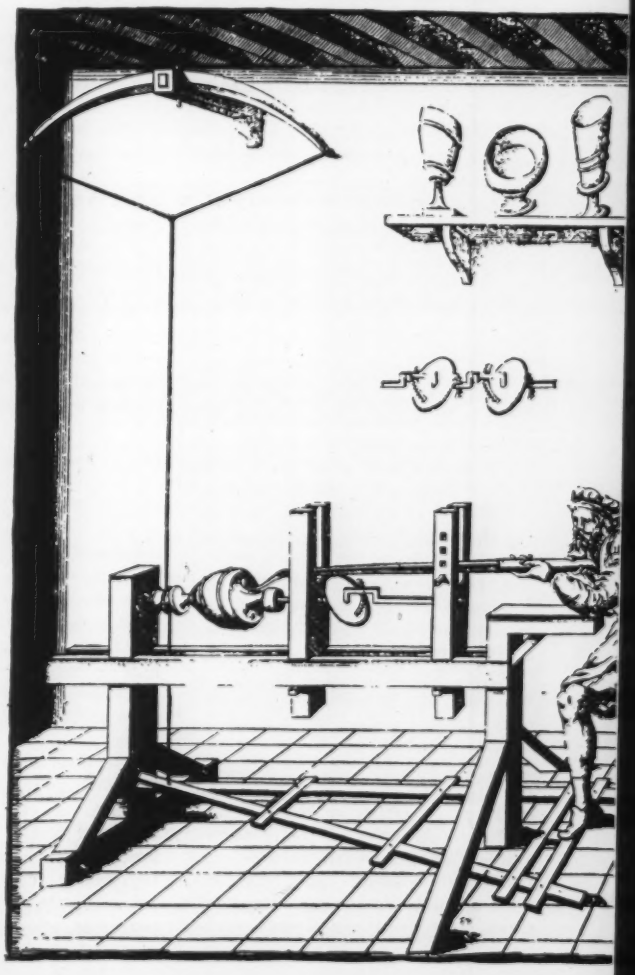
By 1780 the improved machinery available to a number of industries (textile, brewing, founding, forging) was held to limited production for lack of power. This was a direct demand for rotating or mill engines. Watt's partner, Matthew Boulton, realizing that the need for reciprocating pumping engines was limited, urged the development of a rotative engine that the growth industries of the day might provide another market.

THE construction of a rotary engine presented several problems. In appearance the Watt engines resembled the Newcomen type—vertical steam and pump cylinders, with the piston of each connected by means of a chain to the ends of the oscillating beam. These chains could exert only pulls. For double-action and more continuous flow of power, a push as well as a pull would have to be transmitted from the reciprocating steam piston to the beam end moving in a circular arc. Watt replaced the chain between piston and beam end by means of a linkage that has come to be known as the "Watt straight-line motion." Of all his inventions, this was the one of which Watt was proudest.

There still remained the problem of converting the oscillating motion of the other beam end (formerly connected to a pump) into a rotary or shaft motion. The four-bar linkage[1] (as we generally call it today) or treadle drive, with which many are familiar in terms of the foot-powered sewing machine of just a generation ago, was old in Watt's time. In fact, this crank-and-connecting-rod assemblage had been used in foot-lathes as well as machines for grinding grain. At about the time Watt wanted to use it, however, someone patented it. To avoid the payment of royalties, Watt devised and patented in 1781-82 several proposals that were substitutes for the crank. Of these, the "sun-

[1]In the latter part of the 19th century these linkages were called "three-bar," the frame (or fourth link) not being explicitly recognized. Svoboda, in his *Computing Mechanisms and Linkages* adheres to this older British usage.

Bow lathe with cam-guided tool for turning skewed shapes, 1578. (From Besson)



and-planet gear" was the device adopted for the rotative engine. The flywheel had been patented too, and Watt had to pay a royalty to Matthew Wasborough for the privilege of using the flywheel to regulate the motion of the engine.

A consideration of the developments to date shows an avoidance of the rectilinear guides of the familiar crosshead type. The reason for this was simple—straight and flat surfaces were too difficult to make: the planer was not to be invented until 1815. On the other hand, circular components of small diameter such as the pins of a linkage were relatively easy to fashion, the lathe being one of the earliest of man's tools. Indeed, the difficulty of making crossheads of the now conventional type led to intensive efforts by 19th century mathematicians and artisans to devise "straight-line" or "parallel" motions from assemblages of bars—linkwork—to convert reciprocating motion into oscillating or vice versa. Many of them, like the Watt motion, gave only approximations to a straight line, but there were discrete portions that were adequately close.

The metal-cutting tools of the late 18th century—the time of Watt and the American Revolutionary War—were little better than those of the Middle Ages. All principal machinery members were of wood for ease of fashioning and assembly; only the fastenings and the smaller parts were of metal, as forgings or castings. The lathes were

Bibliography . . . with notes thereon

Even a glance at the bibliography of almost any of the modern books noted would show the impossible task facing the completely serious writer were he to attempt a critical study of all the sources he might expect to find appropriate. It is impossible, too, to list all of the sources from which the material of this informal history were drawn. Those that seemed particularly pertinent or interesting are noted. Certain of the foreign titles are so well illustrated that language difficulties will be minimal.

As a special science, kinematics or mechanisms does not seem to appear in listings. In consequence the material developed a curious range of titles with the pursuit of ideas.

Georgius Agricola (1494-1555)
1556: *De re Metallica*, Basel
1912: English translation by H. C. and L. H. Hoover, The Mining Engineer, London.
1950: Reprinting of Hoover translation, Dover Publications, New York, 638 Pages, Illust. and Facsim.

Georgius Agricola was born Georg Bauer in Saxony; his name was Latinized according to the custom of the times when he entered the University of Leipzig. On completing thorough training in philosophy, natural sciences and medicine at the Universities of Bologna and Venice, he settled as town physician in Joachimsthal in 1527, the most active mining district in central Europe. Joachimsthal (the vale of St. Joachim) was the site of a rich silver mine; it was a boom town (as in the American gold rush). It was here that the silver coin almost immediately named "Joachimsthaler," bearing the effigy of St. Joachim, had been struck some years before. Widely circulated in Europe, the coin became known as a "thaler," with ultimate Anglicization to "dollar."

Agricola was a great humanist whose search for knowledge led him into many scientific fields. He was a Latin and Greek scholar of considerable stature, but his fame comes from his account of the development of mining methods, metallurgical processes, geology, mineralogy and mining law from the earliest times to the 16th century. It became the standard reference work for the next two centuries. Book (i.e., Chapter) VI, devoted in the main to winding, ventilating and pumping machinery, is of particular interest to us. It shows a great variety of mechanical devices, and like the whole work, is lavishly illustrated with legible woodcuts.

The English translation was a five-year labor of love by Herbert Hoover (later President of the United States) and his wife. It was derived from the first Latin edition noted above. The Hoovers' annotations and appendices are themselves as fascinating as the text they interpret.

Jacques Besson (flourished about 1570)
1578: *Theatrum Instrumentorum Machinarum*, Lyons.

Besson was a military engineer at the court of France who followed da Vinci after the latter's death in 1519. Known as the "Engineer and Mathematician of the King," Besson had been professor of mathematics at Orleans. In this post he had exhibited great ingenuity in the construction of demonstration apparatus for the support of his lectures.

The book was written (in Latin) in 1569, and published posthumously in 1578. It contains 59 very neatly executed copper engravings, and is perhaps the first machine construction text. The "picture-book style" originated here was to continue for centuries, for drawings could be understood even if the text was beyond the reader's abilities.

Georg Andreas Boeckler (flourished about 1648-1685)
1661: *Theatrum Machinarum Novum*, 154 Illus., Nuremberg.

Little seems to be known of Boeckler. Like Besson, he furnished a machine construction text which, although it carried a Latin title, was written in German. It was specifically devoted to wheeled machinery for mills and materials handling.

Somers Clarke and Reginald Engelbach
1930: *Ancient Egyptian Masonry*, 238 Pages, 269 Illus., Oxford University Press, London.

The story of the building craft, detailing the hardships of winning, transporting and erecting large masses of stone. The observations on the methods, tools, mechanical devices and ingenuity (as the use of dry sand as a "hydraulic fluid") are revealing.

Henry W. Dickinson and Hugh P. Vowles
1943: *James Watt and the Industrial Revolution*, 59 Pages, 11 Illus., published for the British Council by Longmans, Green and Co.

An informative, illustrated story sympathetically told under two headings, "Prelude to Steam Power" and "James Watt and his Times." Dickinson has served as biographer to other engineers—Fulton, Boulton and Trevithick—with equal understanding of the man, his contributions and the times.

Hermann Diels (1848-1922)
1924: *Antike Technik*, 243 Pages, 78 Illus., Tables, Teubner, Leipzig.

A collection of lectures—The Science and Technology of the Hellenes, Antique Doors and Locks, Steam Engines, Automata and Taximeter, Antique Telegraphs, Artillery, Chemistry and Clocks. A scholarly and highly regarded work, written by a professor of classical philology of the University of Berlin, known for his studies of Greek

primitive in the extreme. The work was suspended on two dead centers, a cord was wrapped around the work itself, one end being fastened to a floor treadle, the other end to a long springy wooden beam or bow secured to the ceiling. Obviously the work turned in both directions—and under a hand-guided tool at that. The live center, allowing a unidirectional motion from a belt drive whose motive power was usually derived from a man turning a crank (the phrase "and a strong Irishman to turn it" occurs), and the slide-rest had been invented, but were not yet in general use. The wooden machine frame was not stiff or accurate enough to permit a good job to be done when cutting metal.

Planing machines for wood and metal did not exist, and the drilling and boring machines were quite inadequate. The bored hole of a cannon, for example, was little better than the cored hole of the casting.

All the engine builders had great difficuly with their cylinders. Typically, an early Watt engine cylinder was out of round by ⅜-in., in a nominal diameter of 18 in. and a length of 20 in.! A new boring machine was developed by John Wilkinson in 1776. Boulton wrote that "Mr. Wilkinson has bored us several cylinders almost without error; that of 50 inches diameter, which we have put up

philosophy, technology and medicine.

E. B. Ellington
1899: "Hydraulic Transmission of Power," *Engineering Magazine* (now *Factory Management and Maintenance*), Vol. 17, New York.

Today's hydraulic power transmission systems are limited in scope, being confined to the geography of a single machine, as a car, truck, aircraft or machine tool. This story of the networks of many miles of piping laid under cities gives the details of a practice current only two generations ago. Mr. Ellington felt that electricity had no future.

Conrad Matschoss (1871-1942)
1954: *Grosse Ingenieure*, nearly 400 Pages, 55 Illus., 4th ed., Lehmann's Verlag, Munich.

Matschoss, an authority on the history of technology and industry, presents biographies of famous engineers for three periods: (1) from olden times to Hero and Vitruvius (17 pages), (2) from the collapse of the Roman Empire to the 18th century (50 pages) and (3) from Watt onward (300 pages).

Franz Maria Feldhaus (1874-
1953: *Die Geschichte des technischen Zeichnens*, 110 Pages, 80 Illus., Franz Kuhlmann KG., Wilhelmshaven.

To celebrate their 50th business anniversary, the German drawing-instrument firm of Kuhlmann commissioned a foremost historian of technology to write this unique history of technical drawing.

Obviously the topics of the drawings are of great interest, for in part they deal with apparata for milling grain and sawing wood, automata, engines and devices for war. The changing techniques and the development of the tools of the draftsman are presented with the aid of uncommon pictures.

Jacob Leupold (1674-1727)
1774: *Theatrum Machinarum Generale*, Leipzig, 1st Ed., 1724.
1774: *Theatrum Machinarum Hydrotechnicarum*, Leipzig, 2nd Ed.

Despite the Latin titles, the books are in German. The two noted above are part of a nine-volume sequence that constitute a "display of the mechanical sciences" published during the period 1724-39. There are in all some 492 copper engravings. These books, as machine construction texts, were directed at "artists, craftsmen and such people who have no knowledge of languages or other subjects, and therefore have no opportunity to . . . search out . . . the information from many sources . . . needed to maintain, build and use such machines (as those displayed)."

Leupold, who studied theology but supported himself by craftsmanship—he established a very successful instrument shop in Leipzig—detailed the early 18th century practice of machines, instruments, water supplies and bridge-building. These books are a most important source for the state of knowledge and ideas of that time.

Curt Merckel
1899: *Die Ingenieurtechnik im Altertum*, over 658 Pages, 261 Illus., Springer, Berlin.

The technology of the ancients is discussed at length in word and picture to create an impressive story of past achievements. The main topics are tools, materials, water supply, canals, roads and bridges, harbors and city plans. The biographies of the ancient engineers are necessarily scant, but informative.

(Sir) Ralph Payne-Gallwey (1848-1916)
1907: *Projectile Throwing Engines of the Ancients*, 70 Pages, 40 Illus., Longmans, Green and Co., London, New York.

A sequel to *The Crossbow, with a Treatise on the Balista and Catapults of the Ancients* (1903). The present volume gives details of catapults, balistae and trebuchets (some of which were reconstructed from old plans). Included are notes on siege engines and their effects in warfare. The performance data of Turkish bows are astonishing.

Karl Ploetz (1819-1881)
1924: *Ploetz' Epitome of History* (766 Pages). Originally translated from the German and enlarged by W. H. Tillinghast in 1883, this edition was revised by Harry Elmer Barnes for Blue Ribbon Books, New York. A modernized version due to W. L. Langer appeared in 1948.

A brief, connected narrative accompanied by a clear, well-graduated chronology which emphasizes the sequence of events. It is a historical table conveniently referenced, and complete enough to permit the discovery of serious flaws in the so-called historical movies.

Franz Reuleaux (1829-1905)
1876: *Kinematics of Machinery*, translation by A. B. W. Kennedy, MacMillan and Co., London.
1894: *The Constructor*, translation by H. H. Suplee, Philadelphia.
1900: *Lehrbuch der Kinematik*, Vol. 2, F. Vieweg und Sohn, Braunschweig.

The fundamental concepts that distinguish the methods of modern kinematics from the older empiricism stem from Reuleaux. They include the recognition of the basic parts of mechanisms, the link, the kinematic chain with its constrained motion, and the search for a symbolic notation that would leaven art with science and lead to formal methods of mechanism synthesis.

For many years a professor at the Technische Hochschule Charlottenburg, Reuleaux was also a pioneer in the area of machine design. Historical sketches of mechanical developments, and a study of the mechanism features of animal and insect bodies provide good reading in the third (untranslated) volume.

George Sarton (1884-
1952: *A Guide to the History of Science*, 316 Pages, Chronica Botanica Co., Waltham, Mass.

XUM

at Tipton does not err the thickness of an old shilling in any part." Wilkinson's boring machine made the steam engine a commercial success. Incidentally, it was Wilkinson who bought the first rotative engine to blow the bellows of his iron works.

The mechanic of Watt's day had few and crude tools: a hammer, file, calipers of a kind, a foot-rule and a "worn shilling" (as a feeler gage) constituted his kit. Machine parts were preferably cast, for intricacies of form were thus possible; bolt holes were formed by coring. Forgings were used for critical parts.

In passing, it should be mentioned that the Watt fly-ball governor was not claimed as an invention, but was an adaptation of a device previously used to regulate the speed of windmills and control the distance between millstones. The steam engine indicator was a Watt invention of 1796.

The 18th century is justly known as the Century of Revolution, for there were three: the Industrial

Bibliography (cont.)

Three introductory essays—Science and Tradition, The Tradition of Ancient and Medieval Science, Is it Possible to Teach the History of Science — comprise the first 66 pages. They really communicate the spirit and philosophy of historical curiosity. The rest of the book lists source material—an appalling amount!

Professor Sarton (Harvard) is a mathematician by academic birth, a historian of science by choice. A native Belgian, he emigrated to America during the first World War and is perhaps the most distinguished figure among the writers on the history of science.

C. Singer, E. J. Holmyard and **A. R. Hall**
1954: *A History of Technology*, Vol. 1, 800 Pages, Illus., Oxford.

This Volume I has the subtitle "From Early Times to the Fall of Ancient Empires" (circa B.C. 1500). Four more volumes are promised to bring things up to date. The material presented was drawn from 29 contributors, each an authority in his field. The three editors, themselves well-known historians of science and technology, have created a most engaging story.

Robert Henry Thurston (1839-1903)
1939: *A History of the Growth of the Steam Engine*, 550 Pages, Illus., supplemented by W. N. Barnard, Cornell University Press, Ithaca. Original Edition appeared in 1878; the 1939 or Centennial Edition celebrates the hundredth anniversary of Thurston's birth.

Gives, among other things, details and dimensions of early engines, commentaries on Watt's contemporaries, and information on steam locomotion and steam navigation.

Wilhelm Treue
1954: *Die Kulturgeschichte der Schraube*, 166 Pages, 174 Illus., Verlag F. Bruckmann, Munich.

This book, like *Die Geschichte des technischen Zeichnens*, was also published at the behest of an industrial concern, Kamax-Werke Rudolph Kellermann. In the foreword, Mr. Kellermann remarks that the development of a specialized industry rests squarely on continuous connection with research. The industrial specialist, he says, must remain in contact with science, but not only within the narrow realm of his specialty; he must do so on a wide base. Because of this philosophy he engaged Prof. Dr. Treue (University of Goettingen) to write the history of his firm's specialty, the screw.

The story of the screw is traced to the 18th century. If nothing else can be read, the pictures alone are worth seeing, for most of them are not available in other sources.

William C. Unwin (1838-1933)
1894: *On the Development and Transmission of Power from Central Stations*, 312 Pages, Illus., Longman's, Green and Company, London, New York.

This is the story of power generation and transmission in the last half of the 19th century. Then a "central station" furnished steam, water or air under pressure or vacuum through a network of pipes in a metropolitan area. In some regions a (central station) hydraulic turbine drove machinery remote from a river's edge by means of belts and pulleys. Ultimately came the familiar gas and electric services of today.

Professor Unwin was a distinguished British civil engineer, who wrote also on the materials and machine design of his period.

Abbott P. Usher (1883-
1954: *A History of Mechanical Inventions*, 396 Pages, Illus., Harvard University Press, Cambridge, Mass.

The first edition of 1929 became a standard reference work. The present volume has been completely revised and substantially enlarged. The first four chapters develop a theory of invention based on Gestalt psychology—that problem solutions come from a grasp of the logical significance of the whole situation rather than from the blundering tactics of trial and error. Subsequently we are led through sections on the mechanical equipment of pre-Christian antiquity, water wheels, windmills, clocks, printing, power production, and tools.

The author is professor of Economics (Emeritus) at Harvard University.

Pollio Marcus Vitruvius (1st century B.C.)
1496: *De Architectura Libri Decem* (First Printing, Rome)
1914: Translation *Vitruvius, the Ten Books on Architecture*, 319 Pages, 61 Illus., by Morris H. Morgan, Professor of Classical Philology at Harvard, Harvard University Press, Cambridge, Mass.

The manuscript was lost for a long time, not being found until the 15th century in St. Gall. Vitruvius was the chief authority on architecture during the classical revival—Michelangelo and Palladio were careful students of the text. The topics include: the education of the architect; city planning; building materials; construction of temples, residences and theaters; water supply; astronomy and machines (Book X).

Vitruvius seems to have been the one who recorded the story of Archimedes' discovery of the principle of floating bodies ("Eureka!"). This appears in the preface to Book IX.

The first English translation was made in 1692 from an earlier translation into French. Another English rendering was made by J. Gwilt (London 1826, reprinted 1875). An early edition of De Architectura (as that printed in Paris in 1547) was furnished with drawings by the editors; the inclusion of more such illustrations with the Morgan translation would have given an even more interesting book.

Revolution, the American War of Independence and the awful cataclysm that overtook France. The first we have seen originate in England at the hands of very practical men. Science was dormant in England and Germany — the great lights, Newton and Leibniz, belonged to the past century and except for Gauss, Germany had no great name. But in France it was different, for here an extremely brilliant group of men flourished at about the time of the Industrial Revolution. Their influence was in terms of ideas rather than machines, although machines had something to do with the dissatisfactions that erupted in the France of 1789.

Over the course of twenty years, from 1762 to 1782, Diderot and D'Alembert, the first a philosopher and the second a mathematician, published the *Encyclopedie ou Dictionnaire raisonne des Sciences, des Arts et des Metiers*: 35 volumes with 3129 illustrations. This work was devoted to portraying the knowledge and abilities of the manual trades and technologist as clearly and thoroughly as previous publications had treated theology, philosophy, law and medicine. The illustrations were beautifully done and almost self-explanatory; knowledge was conveyed by pictures, for most people could not read. The encyclopedia met with great resistance from the ruling circles, for they recognized the dangers of education of the masses in a land where there was no liberty. Napoleon Bonaparte remarked later that the encyclopedia was a spiritual preparation for the Revolution.

In terms of intellectual progress, France was not only at its peak but it also ranked first in scientific leadership when it was plunged into the Revolution in 1789. Contemporaries of the Revolution who had already done their creative work included the mathematicians Laplace, Lagrange, Legendre, Fourier, Monge (who invented descriptive geometry), and Lavoisier the chemist. In fact, some had been part of the liberal movement that preceded the Revolution. Some were more than drawn into the turmoil, and it was inevitable that a few, among them Lavoisier, would ride the tumbrils to the guillotine when they exchanged science for politics. But on the whole, the pursuit of science was neither arrested nor destroyed by the Revolution itself, by the waves of emigration or by the wars of the Republic, Consulate and Empire under Bonaparte.

In 1792, the outbreak of the first of the many wars not to end until 1815, was met with "a mobilization of science". (There is a familiar ring to that phrase!) At this time, too, the Academy of Sciences was concerned with establishing a decimal system of weights and measures designed for modern trade and industry. The subject of the Academy's annual prize contest in 1793 (the year the king, Louis XVI, was finally executed) was the theoretical analysis of the operation of steam engines, with suggestions for improvements on engines. This problem was not answered until about a generation later (1824) by Sadi Carnot.

The survivors of the Revolution — the majority of the intellectuals — functioned as inspiring teachers of the Napoleonic generation. Their work was reflected in the diversities of the talents that blossomed in early 19th-century France, represented in part by Gay-Lussac, Cauchy, and Fresnel.

THE 19th century was one of tremendous accomplishment in the developing, exploiting and perfecting of the basic mechanical components through the use of better and newer materials and tools, analytical studies springing from a great scientific curiosity and ingenuity. New combinations, enormous units and greater efficiencies were the result. By the end of the century the mechanical devices were wed to the new giant, electricity. Rather abruptly we leave this century in which machines matured and bred new ones; we come to the present.

Under the stimulus of the 20th-century's ever-expanding economy and a generally increasing demand for all types of goods, coupled with higher material costs and an apparently inadequate labor force, today's technology has accelerated mass production by the adoption of automation — the arraying of automatic machinery needed to produce a given article. Perhaps it is presumptuous to consider automation a "Second Industrial Revolution," but the implications of a technology and economy firmly built on automatic processing and manufacturing industries are far-reaching and could suggest such a conclusion. Time will tell.

Extra Copies

Reprints of this group of three articles, "Men and Machines—an Informal History," are available for $1.00 each from: Reader Service Dept., *Machine Design*, Penton Bldg., Cleveland 13, O.

Tips and Techniques

Using Small Magnets

A SUPPLY of small magnets can come in handy as a set of "third hands," useful for holding a steel rule in an awkward position, for holding important notes on your drafting lamp or drafting machine, for help in putting together tricky assemblies, for balancing awkward parts while measuring, and for a hundred other helpful uses. — ELMER CERNY, *Chicago, Ill.*

XUM

DESIGNING ELECTRONIC EQUIPMENT FOR MAINTAINABILITY *(Third of a Series)*

DESIGN OF COVERS

By John D. Folley Jr. and James W. Altman

Research Scientists
American Institute for Research
Pittsburgh

Design of covers and cases for electronic equipment plays an important role in ease of maintenance. Covers and cases that are not properly designed create unnecessary maintenance delays and may even cause damage to delicate equipment components or injury to maintenance personnel. This article presents recommendations for cover and case design.

DESIRABLE maintainability features in the design of a covering or case for electronic units depend to a large extent on the maintenance operations to be performed on the units. The major feature that should be designed into covers or cases is ease of putting them on and taking them off. This means, among other things, that they should not fit so tightly that painstaking care has to be taken in fitting them on. Also, the number of fasteners holding them in place should be minimized. It should be possible to open or remove the case or cover to gain access to interior components without removing the unit from its installed position.

Structural Considerations: Electronic equipment should be designed so that cases can be lifted off equipment units rather than units lifted out of the case, Fig. 1. This recommendation is particularly true for heavy units.

Make cases enough larger than the units they enclose so that wires and other components are not likely to be damaged when the cases are put on or taken off.

When the edges of a case must be slid over sealing material such as rubber stripping, the sealing material should be adhered tightly enough to prevent it from buckling or tearing which might cause damage to the seal or jam the case.

Use hinged covers to reduce the number of fasteners needed. Nonpressurized units may need only one fastener with a hinged cover. Keep in mind that a hinged cover requires a space equal to the size of the cover in which to open; this requirement may be a disadvantage.

The method of opening a cover should be obvious. If it is not readily apparent from the construction of the cover itself, an instruction plate should be permanently attached to the outside of the cover. Also, it should be obvious when a cover is in place but not secured. Otherwise, a unit may be

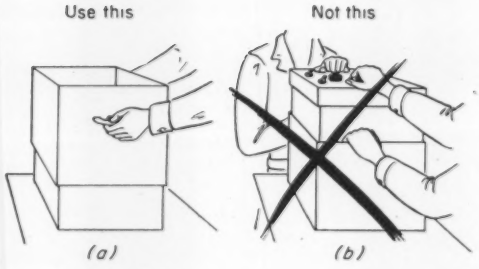


Fig. 1—Electronic equipment units designed with removable cases, *a*, are preferable to designs where units must be lifted from cases, *b*.

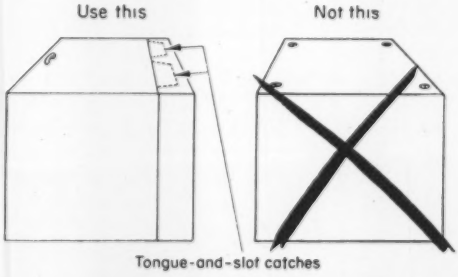


Fig. 2—To fasten covers, use tongue-and-slot catches to minimize number of fasteners required.

AND CASES

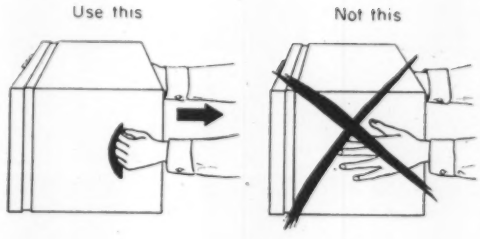


Fig. 3—Always provide handles on covers to facilitate removal of cover and carrying of the unit.

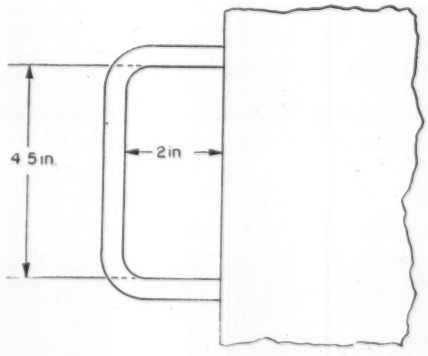


Fig. 4—Recommended minimum dimensions for electronic-equipment handles.

picked up by its loose cover and dropped.

Covers and cases should have rounded corners and edges for safety.

Fasteners for Covers: Use captive fasteners wherever feasible. Avoid the use of loose washers and loose nuts. Make maximum use of tongue-and-slot catches, Fig. 2, to minimize number of fasteners required.

Use as few fasteners as possible to maintain required strength and bonding. In most applications one fastener at each corner of a rectangular cover or three on a round cover will be adequate. In some designs one fastener at each end of a diagonal will be sufficient.

Fasteners for one-piece cases should be located to permit easy accessibility from a convenient working position when units are in normal installed positions.

Fasteners on equipment covers should be operable either with no tools or with standard hand tools only. These fasteners should preferably be quick acting and require only part of a turn or a snap action to fasten or unfasten. If bolts are needed, the number of turns required to tighten them should be kept to a minimum.

Use the same size and type of fasteners for all covers and cases on a given piece of equipment where practicable. There is an exception. If a system has one or two pressurized units requiring large, fine-threaded screws to hold the pressure, do not use these types of screws on other units having only dust covers. Use quick-acting fasteners on the dust covers.

If screws with different thread pitches are used, they should be of different nominal sizes. Otherwise screws of the wrong size may be forced into holes with wrong thread pitches and stripped.

When fine-threaded fasteners must be used, it is best to employ "positive gripper" type heads like hex-head or Allen-head so a ratchet tool can be used readily. Hex-head screws should also be slotted so that a screwdriver can be substituted for a wrench if necessary.

Handles: Provide handles on covers to facilitate removal of the cover, Fig. 3, and carrying of the unit.

Locate handles over the center of gravity of units to prevent tendency of tipping when lifted or carried.

Handles that technicians must grip firmly should be at least 4.5 in. in height and 2 in. in depth as illustrated in Fig. 4. Handles that are smaller will cause the technician's hands to be squeezed, resulting in discomfort and inability to exert full force.

Other Design Characteristics: Covers and cases should have their own stock number since they may have to be replaced.

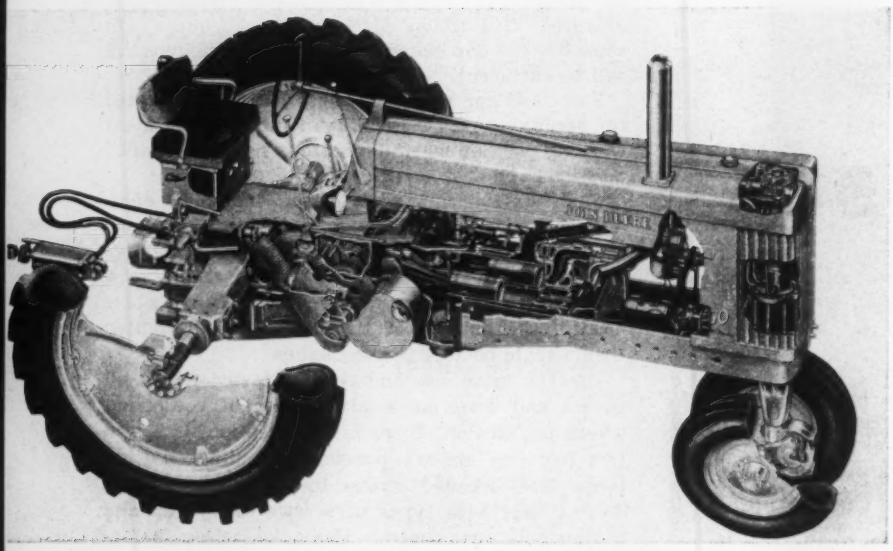
Ventilation holes in covers should be small enough so test probes or other conductors cannot be inserted inadvertently and touch high-voltage sources.

BIBLIOGRAPHY

This article is the third in a co-ordinated series by John D. Folley Jr. and James W. Altman. Previous articles, and issues of MACHINE DESIGN in which they appeared are:

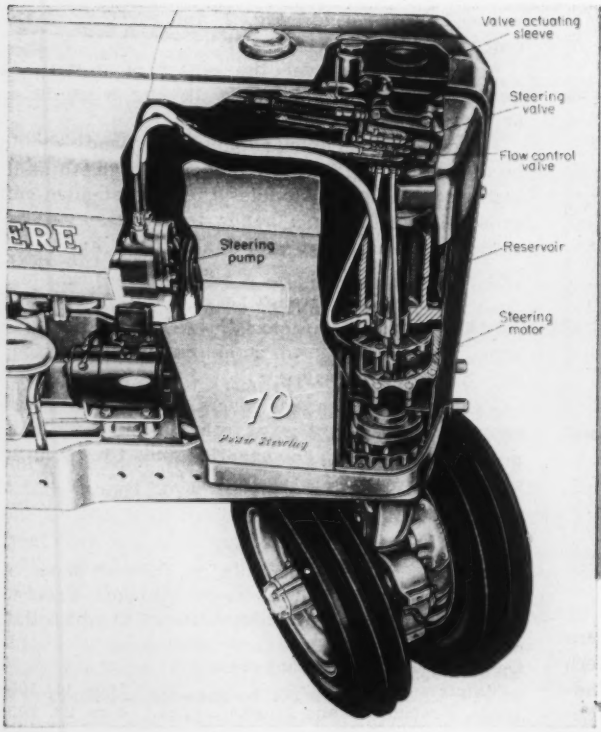
Designing Electronic Equipment for Maintainability ..... June 14, 1956
Units, Assemblies and Subassemblies ... June 28, 1956

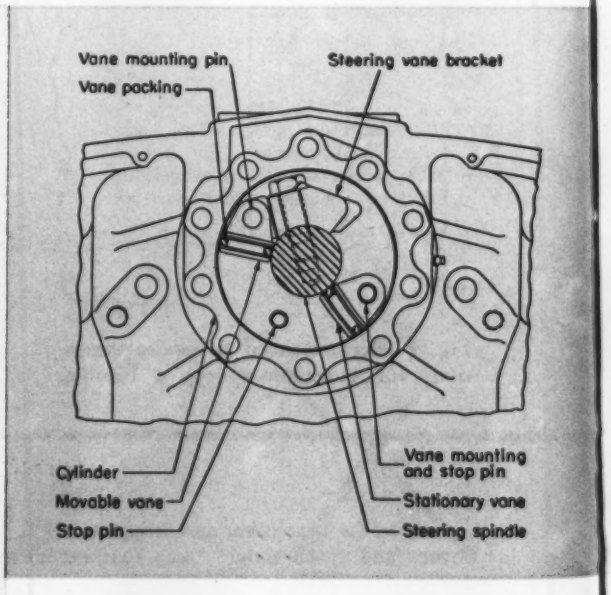
TRACTOR INCORPORATES



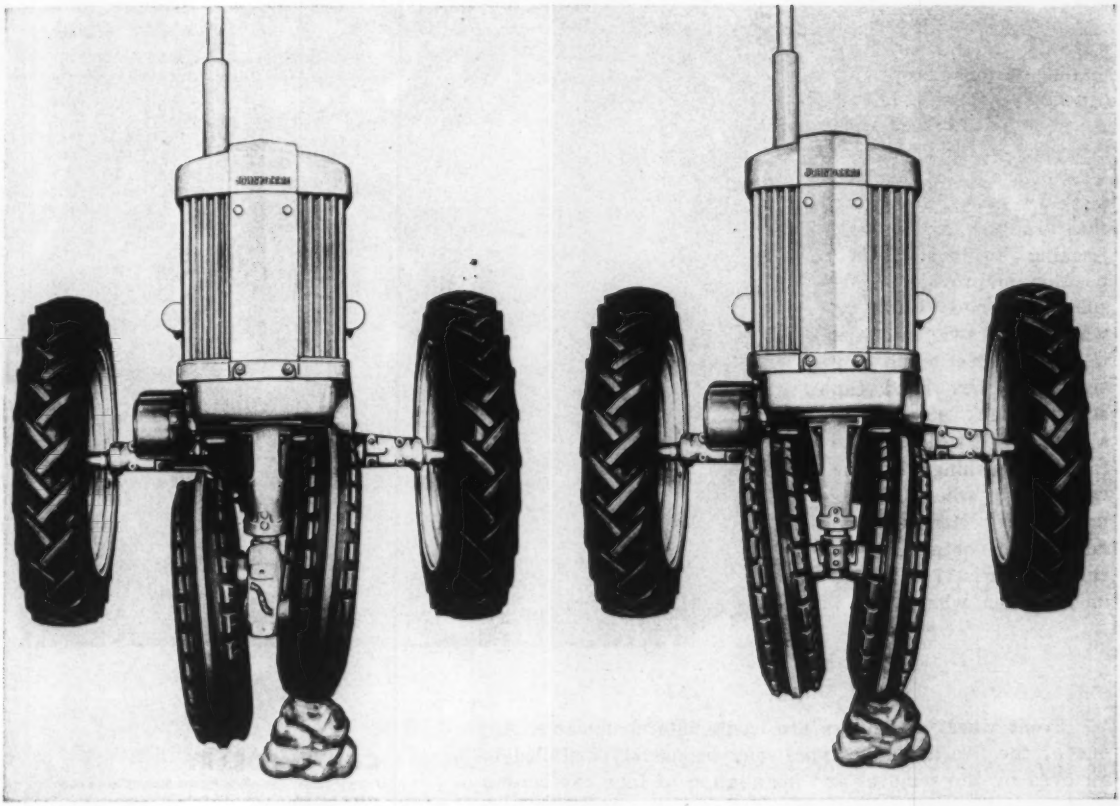
POWER steering, quick interchangeability of front wheels, independent front wheel suspension and quick changing of rear wheel tread are all features of three recently introduced John Deere agricultural tractors. Manufactured by Deere & Co., the tractors are powered by two-cylinder engines which may be operated on gasoline, LP-gas, or light or regular grade tractor fuels. Diesel power is also available for the largest model.

Power steering system is very similar to that used on passenger cars and trucks with the exception of the motor. Motion of the steering wheel displaces the steering valve spool to meter oil for the proper direction of turn. The flow control valve serves to regulate oil delivery despite wide variations in engine and, therefore, pump operating speed. To best utilize the available space and to take advantage of direct connection to the steering spindle a vane-type motor is used. Truck and passenger car systems ordinarily employ a cylinder whose output motion is linear. Motion of the vane motor is rotary.

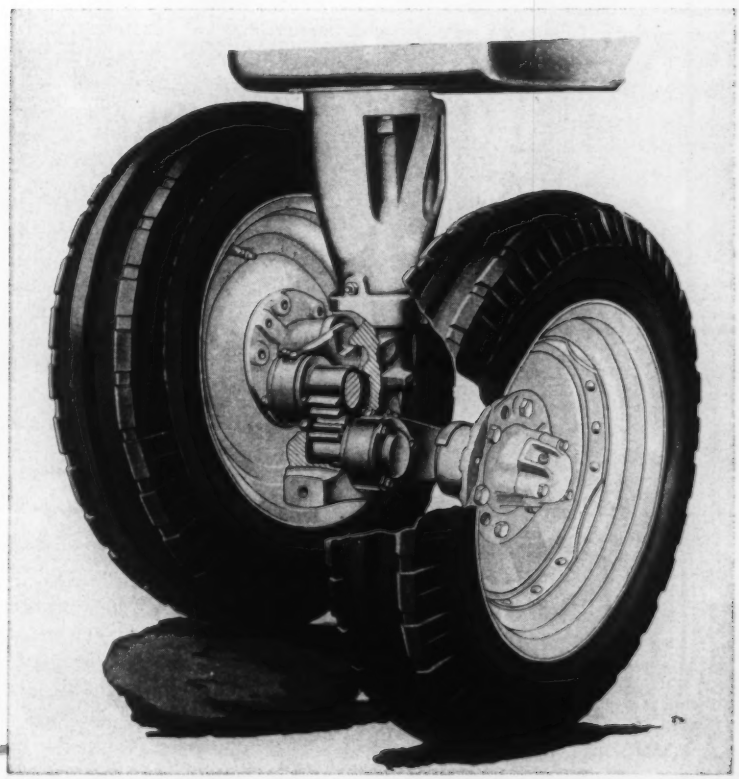




Contemporary

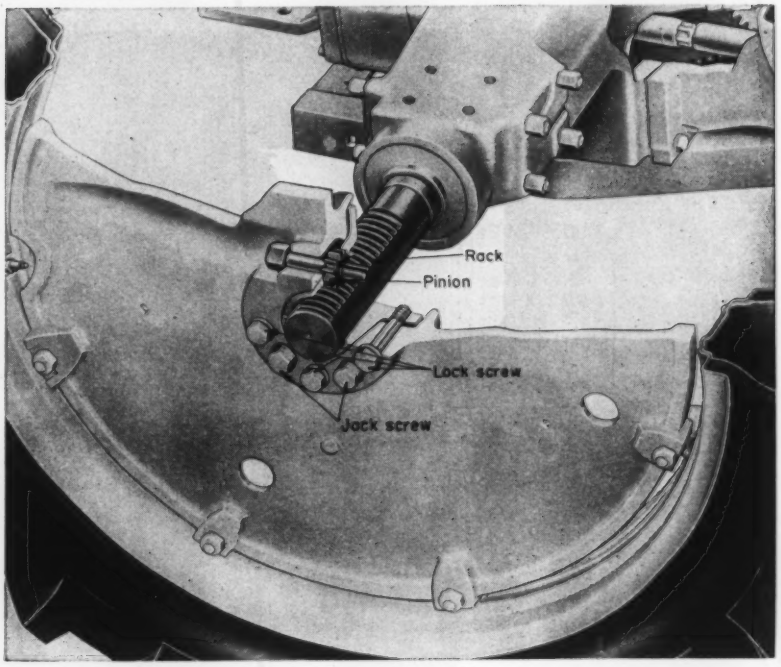


Front wheel loading is equalized when passing over obstructions by a unique construction labelled Roll-O-Matic by the manufacturers. When one front wheel meets an obstacle, such as a stone, it pivots on an arm to raise it while the other is forced downward to assume its share of the load. With a conventional assembly, one front wheel would carry no load. Up-and-down movement of the front end of the tractor is reduced by one-half. Steering wheel fight is appreciably reduced and riding qualities are greatly improved by the system.



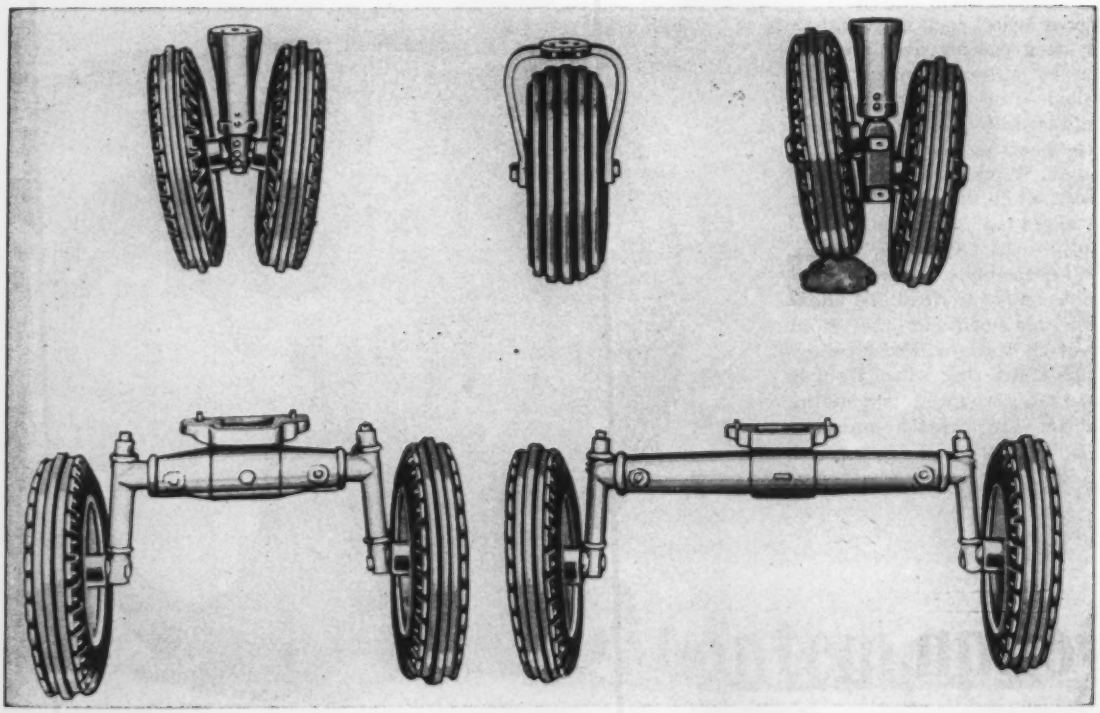
TRACTOR INCORPORATES POWER STEERING

Rear wheel tread is quickly adjustable to match various crop row spacings. A pinion in the wheel hub is rotated with a wrench on the hexagonal head of the pinion shaft to move the wheel along the rack in the axle shaft. Locking in the desired position is provided by a split tapered bushing which is drawn into the tapered wheel hub by tightening hex head cap screws. Jack screws are also provided to loosen the tapered bushing in the wheel hub when adjustment is to be made. Total adjustment obtainable in this manner is 17 in. or 8½ in. for each wheel.



Front wheel assemblies are easily interchangeable. Any one of the five available types may be quickly installed or removed by the removal and installation of four cap screws. The available assemblies are: Roll-O-Matic, single wheel, fixed-dual wheels, 38-in. tread, and adjustable axle.

CONTEMPORARY DESIGN



By J. B. Mohler*
Dept. of Metallurgical Research
Kaiser Aluminum & Chemical Corp.
Spokane, Wash.

Designing

Oil Grooves for sleeve bearings

LUBRICATION FACTORS—TYPES OF GROOVES—GROOVE CROSS-SECTION DESIGNS

BASIC GROOVE CONFIGURATIONS—OIL ENTRY HOLES

AN OIL-LUBRICATED sleeve bearing performs efficiently only when the journal and the bearing are properly separated by an oil film. The oil is the real medium that supports the moving, loaded journal at high mechanical efficiency. The purpose of an oil groove is to convey oil from the area of entry to the load-supporting area of the bearing surface. This is often done by means of a groove just prior to the loaded area and for the full length of the bearing.

If the loaded area shifts during use or if the direction of rotation is reversed then, of course, such a method will not satisfy all conditions. Proper grooving often requires consideration of many factors in addition to the normal position of the loaded journal. The factors include hydrodynamic lubrication, oil friction, oil viscosity, oil supply, points of entry, etc.

Hydrodynamic Lubrication: Rotating motion of a shaft drags oil into the space between the shaft and the bearing. A wedge of oil is built up and the pumping action maintains a moving film of oil over the supporting surface. Oil-film pressures in the loaded area are much higher than the unit-loading pressures based on projected area. Film thicknesses may be of the order of 0.001 to 0.0001-inch, depending on speed, load and viscosity of the lubricant. Oil entry must be in the low-pressure area, often in the vicinity of the parting line, just preceding the high-load area.

*Formerly consultant, New Castle, Pa.

Oil Flow: Lubrication in desired areas depends primarily on feeding of oil to the near vicinity. Lubrication, however, is not the only requirement; oil must be supplied in sufficient volumes. When a continuous flow of oil is required, the moving fluid will resist movement. Therefore, oil holes, oil grooves and clearances must be large enough

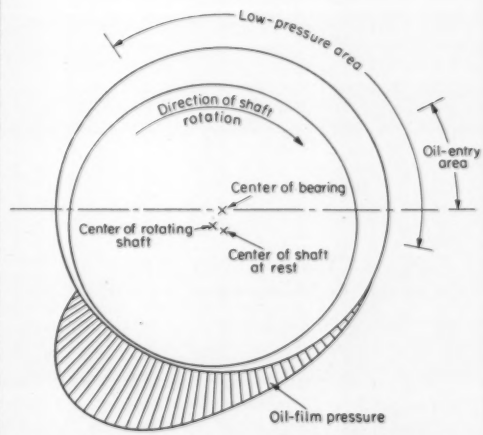


Fig. 1—End view of a bearing and journal showing distribution of oil-film pressure under dynamic conditions.

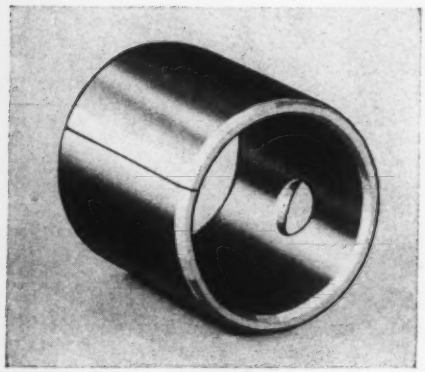


Fig. 2—Sleeve bearing with simple oil-hole design.

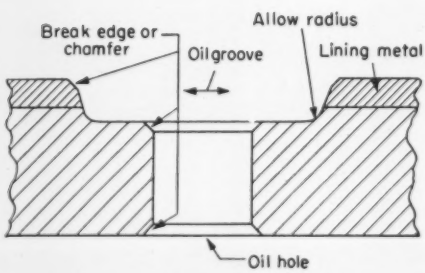


Fig. 3—Cross-section of a bearing demonstrating good design of grooves and oil holes.

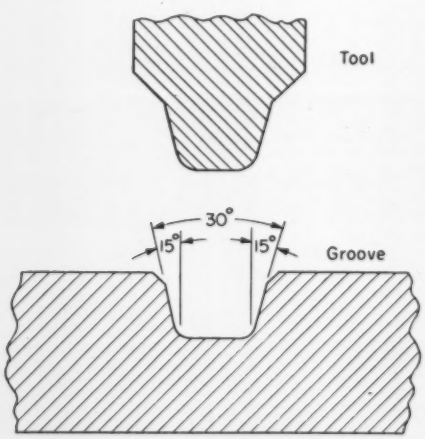


Fig. 4—Above—Tapered oil-groove design. Technique simplifies machining and reduces burrs.

Fig. 5—Right—Flanged bearing with circumferential oil groove. Wide-entry oil holes—known as "fingernail" or "banana" grooves—feed oil to large area in vicinity of hole. "Tear drops" in flange faces collect and feed oil to thrust surfaces.

to pass the desired flow at normal pressures.

Oil Entry: When a bearing depends upon hydrodynamic lubrication, the oil should be introduced in a low-pressure area, Fig. 1. The oil hole should be sufficiently large that it does not offer resistance to flow. In many bearings only an oil hole is required as shown in Fig. 2. A single oil hole may properly feed a bearing surface where the oil is supplied under pressure. If the requirement is merely for an oil-wet surface with just enough oil for replenishment then an oil hole may also suffice.

Oil holes may go into the oil grooves at points other than those indicated in Fig. 1 because the oil grooves provide low-pressure areas wherever they appear.

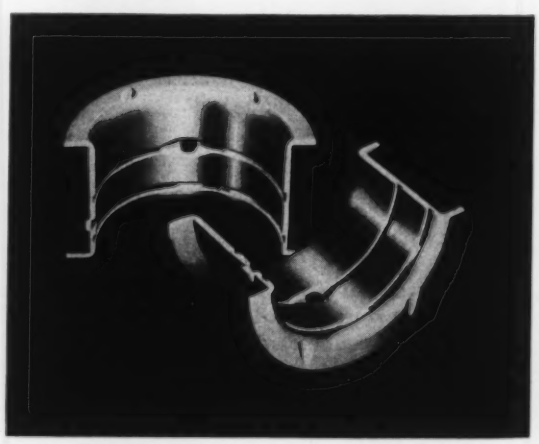
Design of Grooves: Simplicity is the key to oil-groove design. Why use a groove if a plain hole will do the job? Or why use a complicated groove if it can be done with a simple groove?

Machining methods must be kept in mind. Low-cost grooving can be done by broaching, plunge cutting and milling. Spirals, ellipses and figure-eight shapes are also produced on a high-production basis; however, for short runs tooling costs become a considerable item.

Imagination often determines a specific design. Visualization of the oil entry, the surface to be covered and the oil exit serve as design bases. However, imagination should be tempered by simplicity and the cost of machining methods. It may appear easy to lubricate a certain area on a drawing board, but nonconventional shapes give rise to tooling and machining problems.

For a plain oil groove fed by an oil hole, Fig. 3, the basic design requirements are: (1) keep the groove shallow, (2) break or chamfer all edges, and, (3) allow a radius in the corner of the groove.

Shallow grooves are easier to machine than deep grooves. Also a deep groove will weaken the bear-



ing wall, or in the case of a thin-walled, steel-backed bearing, distortion during manufacture may cause difficulty because of the weakened section.

It is becoming rather common practice to machine a slightly tapered groove, Fig. 4. A 30-deg included angle for both sides simplifies tool withdrawal and lessens the formation of burrs during machining.

If the bearing is lined with bearing metal, avoid a groove depth equal to the lining thickness. For a heavy lining, a groove depth less than the lining thickness confines machining to the soft metal. Generally the groove is deeper than the lining thickness. A groove depth equal to the lining thickness may result in tearing of the lining at the bond line during machining.

Expensive hand operations are common in bearing manufacture because of the importance of breaking edges, blending corners and removing of burrs at oil holes and oil grooves. Such blending, rounding, breaking or chamfering of edges is good practice. Where oil velocities will be high, the well-rounded groove helps to change the direction of the oil. This aids development of the oil wedge and helps prevent turbulence in the oil stream.

Sometimes a groove may be made in the form of an enlarged entry-oil hole as shown in Fig. 5. These wide entry holes, often called "fingernail" or "banana" grooves, feed oil to a wide surface in the vicinity of the hole. They may be employed as oil-distributing sources or may blend into a conventional groove.

Oil grooves in the loaded area seriously limit the load capacity of the bearing and cause difficulty with oil entry and formation of the oil film.* Longitudinal or axial grooves in the loaded area, Fig. 6, should be avoided. Circumferential grooves that pass through the loaded area are permissible where suficient bearing area remains to support the load.*

When change of direction is a design factor, spiral, oval or figure-eight grooves may be em-

*S. Kyropoulos—"Oil-Groove Design in Bearings," MACHINE DESIGN, Vol. 28, No. 12, June 14, 1956, Page 119.

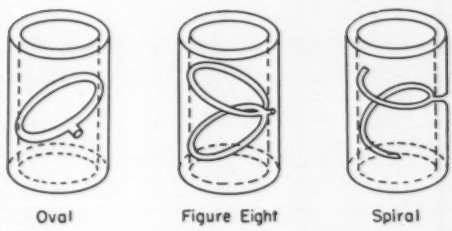


Fig. 7—Above—Typical oil-groove configurations for lubricating bearings designed for bidirectional rotation.

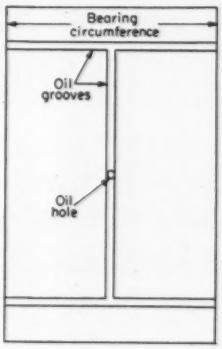


Fig. 8—Right—Developed view of a long bearing with two circumferential oil grooves connected by a longitudinal oil groove.

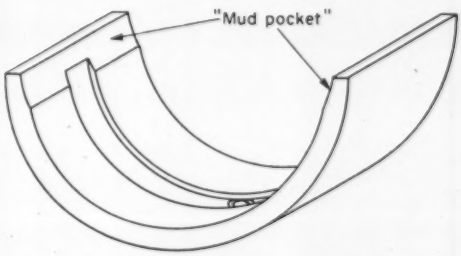


Fig. 9—Above—Insert half bearing with a circumferential oil groove and "mud pockets."

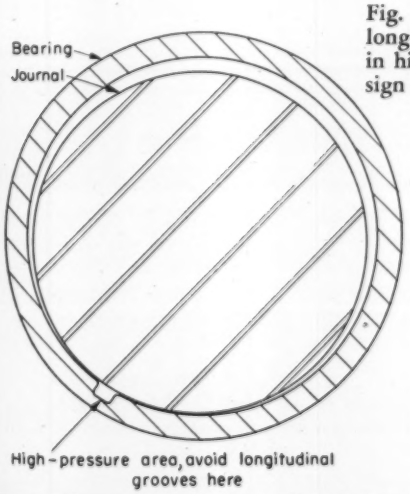
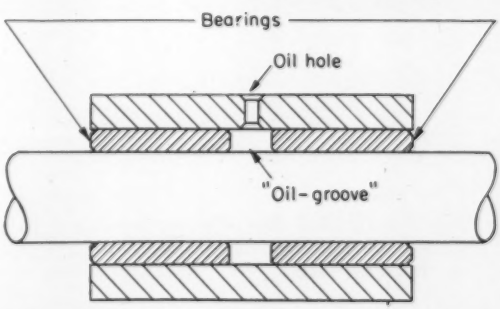


Fig. 6 — Left — Bearing with longitudinal or axial groove in high-pressure area. This design should be avoided.

Fig. 10—Below — Two short bearings spaced appropriately to form a central oil groove. Design may be used in place of one long bearing.



ployed, Fig. 7. These same patterns can be duplicated on the other side of the bearing if it is felt advisable to increase the area fed by the oil groove. For sheet-metal bushings, complicated patterns are not objectionable because these can be pressed into the sheet metal prior to forming the bushing. It is better to use an extensive, shallow pattern than a simple, deep pattern as there is a definite limit to the depth of pressed grooves. Such grooves are generally 0.020-in. deep and less than one-third the wall thickness.

Longitudinal grooves the full length of a bearing are easily machined or broached into solid bronze. Such grooves are satisfactory for low speeds where the drag of a high-viscosity oil assures lubrication. Where pressure lubrication is necessary at higher speeds, the groove can be manufactured short of the bearing ends to assure flooding of the bearing surface. For a long bearing, one longitudinal groove may be used to connect two circumferential grooves, Fig. 8. Excessively long bearings, of course, are to be avoided wherever possible because of high edge loadings due to shaft deflections. Additionally, long bearings are difficult to feed with oil, and this condition may lead to marginal lubrication.

Where pressure lubrication is used, it may be necessary to allow an escape in order to assure a sufficient flow of oil. Free passage of oil through the bearing also avoids trouble with dirt and sludge.

Insert half bearings are frequently manufactured with a circumferential groove and a relief or "mud pocket," Fig. 9, at each parting line to assure oil flow and to pass dirt. The load capacity is not as good for this construction as for oil introduced directly to the bearing surface through an oil hole. Nevertheless it is a popular construction since bearing metals with sufficient load capacity are available. Where it is desirable to use a narrow bearing at the maximum permissible unit loading of bearing material, direct oiling through a hole is used. Introduction of oil through a hole in the shaft also limits load capacity.

A long bearing often causes difficulty with alignment. Two short bearings may be employed to solve such a problem. The space between the bearings can serve as an oil groove, Fig. 10.

Thrust Surfaces: In the flanged bearings in Fig. 5 there are "tear drops" in the flange faces to collect and feed oil to the thrust surfaces. Thrust plates with various means of introducing or holding the oil at the bearing surface are shown Fig. 11. There is no simple set of rules for oiling these surfaces. Design is based on the attempt to wet the entire surface. The availability and pressure of the oil source are used as a basis for design of holes, grooves, indentations, tear drops or spirals to cover such surfaces. It is often necessary to try a design and examine the used part for signs of distress before a final design can be established.

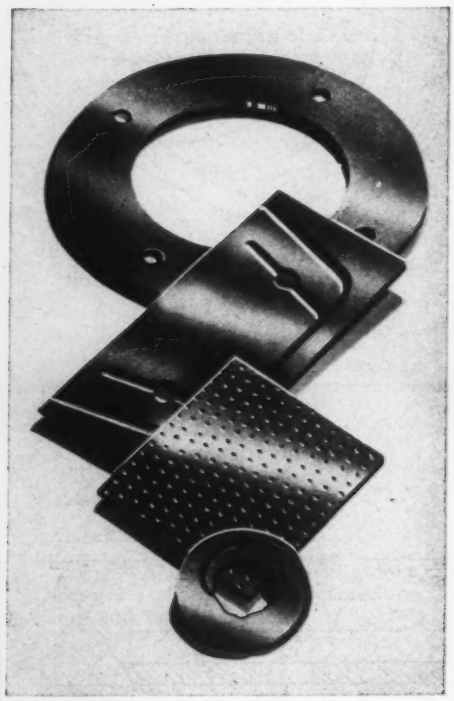


Fig. 11—Typical thrust plate designs used to feed lubricant to thrust surfaces.

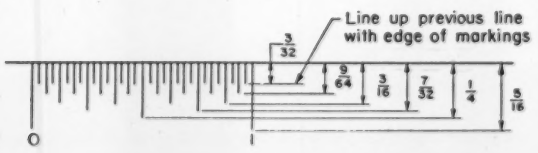
ACKNOWLEDGMENT

The author acknowledges with appreciation the assistance of Mr. T. D. Colbridge, chief engineer, Johnson Bronze Co., in the preparation of this article. All photographs, courtesy Johnson Bronze Co.

Tips and Techniques

Using Scale Markings for Spacing

Accurate parallel lines for lettering or cross sectioning with a drafting machine may be obtained by using the scale markings of plastic scales for spacing. On scales that are graduated in 1/32-in., the sizes shown hold true.—JOSEPH W. YATCHUM, *Canonsburg, Pa.*



Practical design techniques for

Controlling Vibration

in welded machines

. . . a new approach to the problem of designing low-vibration welded structures

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THERE IS STILL opposition to using weldments where vibration is a problem. This viewpoint is based on the erroneous assumption that vibration is worse and damping poorer in a welded structure. It is still often believed that "beefing up" is useful for reducing vibration—that addition of large masses of high-damping-capacity metal is necessary to combat oscillation.

Such "beefing up" is not necessary. Superior machines can be built using welded steel structures if they are properly designed for vibration control. Mass of the machine does not have to be increased.

Reasons why will be detailed in this article. This article will also describe some of the design methods found practical to control vibration in welded structures.

Basic Methods for Vibration Control

Two types of vibration can be recognized as important in machines such as machine tools or production equipment:

1. Vibrations transmitted to the machine's working area from the floor.
2. Internal vibrations transmitted between the working area and other parts of the machine.

In either case, the machine structure serves as the

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The original paper on which this article is based was the recipient of the First Award of $3000 in the James F. Lincoln Arc Welding Foundation Machine Tool Design Award Program. It is published here for the first time.

New design methods presented here have proved to be effective. They are general techniques, applicable to many types of machines. And they have been tested and found practical in the welded base of a new model Bryant internal grinder, now available as the Bryant "Centalign" internal grinder. Among the concepts is an original design for a "damping joint," a welding joint design for damping vibration.

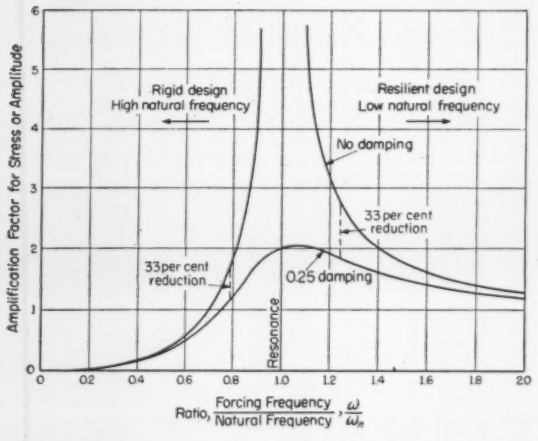

Fig. 1—Basic vibration diagram showing effect of natural frequency of the welded structure on intensity of vibration.

"bridge" between the vibration source and the other machine members.

Transmission of Outside Vibration: Vibrations transmitted from outside the machine can greatly affect working accuracy. They are set up when the entire machine or its parts come into resonance with vibrations generated by trains passing the plant, by overhead cranes, or by other similar outside disturbances.

The natural frequency of the ground floor in factories usually ranges from 3 to 30 cycles per second, depending on the foundations underneath the floor. Hence, where machines are standing on or bolted to the floor, resonance can become very dangerous when the machine has a natural frequency as low as that of the floor.

Effective elimination of outside vibrations requires isolation of the machine from the floor by "soft springs." In other words, deflection of isolator springs must be relatively large, depending upon the weight of the machine. Damping of such isolator springs is generally not desirable.

If all isolator springs deflected at the same instant and by the same amount, the relative positions of working parts would not be changed, and alignment of the machine would not be disturbed by outside vibration. Experience in the field and tests have shown, however, that a small time lag exists in the deflection of the springs if the vibration source is nearer to some of them than to others. The isolator springs deflect irregularly, causing distortion and misalignment within the machine. In most machines, such as accurate machine tools, misalignment between working parts is, to put it mildly, not desired.

To avoid misalignment, the structure must be rigid. It must not permit motion of one portion of the machine relative to another portion. A welded structure can satisfy these conditions readily because ribs, girders and intermediate walls can be placed where they do the most good. Also, a closed box section can be used in a welded steel design.

By contrast, a cast base often requires openings in the walls for core support. It is seldom realized how much wall openings in the base of a machine can reduce its torsional rigidity. Transverse rigidity is also reduced, although to a lesser extent. Even a small gap has this effect.

Transmission of Internal Vibration: Internal vibrations are more difficult to control than external vibrations and are also more important. They are generated within the machine itself, either by unbalance of a moving workpiece or other machine parts, or by the working or cutting process itself.

Some vibration-producing components (such as a motor with an unbalanced rotor) could theoretically be isolated from the machine base. Unfortunately, vibration mounting is often not possible since it involves relatively large movement or deflection of the component, which might impair accuracy.

Vibration isolators between the machine and the floor do not help in reducing internal vibrations and are sometimes even disadvantageous because they prevent dissipation of the vibratory energy through the floor.

Forced vibrations caused by unbalance of masses can be represented by a diagram such as Fig. 1. Intensity of vibration (amplification factor) is plotted against the ratio ω/ω_n, which is the ratio of the frequency of the exciting vibration, ω, to the natural frequency of the machine structure, ω_n. Resonance is indicated by theoretically infinite amplification ratio occurring when $\omega/\omega_n = 1.0$.

According to Fig. 1, intensity of vibration can be kept low by two means. First, the machine can be designed for a low ω/ω_n ratio, essentially to the left of the resonance peak at $\omega/\omega_n = 1$. Second, damping can be introduced. Damping is most effective near resonance.

To obtain a low ω/ω_n ratio, natural frequency should be high. The natural frequency, ω_n, of a single-degree-of freedom system is obtained from

$$\omega_n = \sqrt{\frac{k}{m}} \qquad (1)$$

where k = linear stiffness (spring constant); and m = mass of the structure.

Two things can be done, according to Equation 1, to increase natural frequency of the structure: increase stiffness k, and decrease mass m. The k factor can be made large by designing for rigidity —essentially proper distribution of the material of the structure. Mass, of course, can be kept low by using highly stressed sections, supported structures, etc.

To get the lowest vibration intensity, the structure should be rigid and as light in weight as

possible. Damping should be introduced to take care of conditions approaching resonance. All of these objectives can be attained with welded structures.

Damping Capacity of Cast Iron and Steel: General opinion says that cast iron has inherently greater vibration-damping capacity than steel. This statement, unless properly qualified, is open to plenty of discussion. It is true only under certain conditions.

A hysteresis loop of mechanical vibration[1] is shown in Fig. 2. It may also be termed a dynamic stress-strain diagram.

Hooke's law of proportionality of stress and strain is represented by the straight line *OH* on Fig. 2, where tan α indicates the modulus of elasticity of the given material. For vibration, Hooke's law does not apply accurately, for very simple reasons. Hooke's law assumes perfect elasticity; no damping is theoretically possible. It also does not apply where joints, bearings, or engaging parts in a machine are involved. It is a valid approximation to the real stress-strain curve only for static (slow) deformations.

Under dynamic conditions (vibration), and where engaging parts are involved, application of a load of the same magnitude as represented by *OH* results in a deflection represented by *OA*, called dynamic deflection. Release of the load to zero does not remove all strain; a deflection is retained corresponding to point *B* on Fig. 2.

Direction of the load must be changed (as in the case of vibration) to reduce deflection to zero (point *C*). Point *D* is reached upon further compression until another reversal of the load brings the stress back to zero at point *E*, whereupon a new cycle starts. The plot of Fig. 2 is, of course, highly exaggerated along the strain axis.

It can be proved rigorously that the area of the hysteresis loop of Fig. 2 represents the damping capacity of one cycle of vibration. The larger this area, the greater the damping capacity. Units

[1]References are tabulated at end of article.

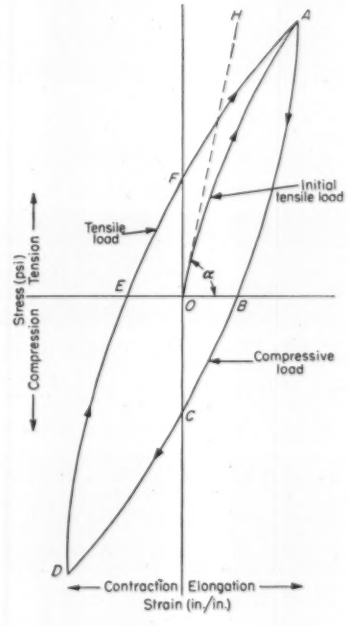

Fig. 2 — Mechanical hysteresis loop for steel. Area of the loop is a measure of damping capacity of the material.

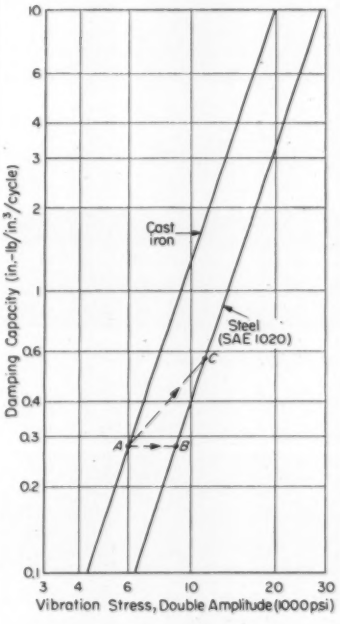

Fig. 3—Comparison of vibration-damping capacity of cast iron and steel. By stressing the steel to reasonably high levels (point *C*), damping capacity can be increased.

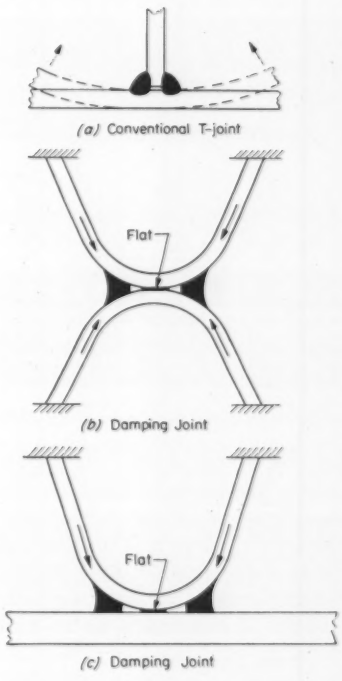

Fig. 4—Conventional filleted T-joint, *a*, and "damping joints," *b* and *c*. In the damping joints, shrinkage stresses caused by fillet welds, and friction between filed flats, are used to damp vibration.

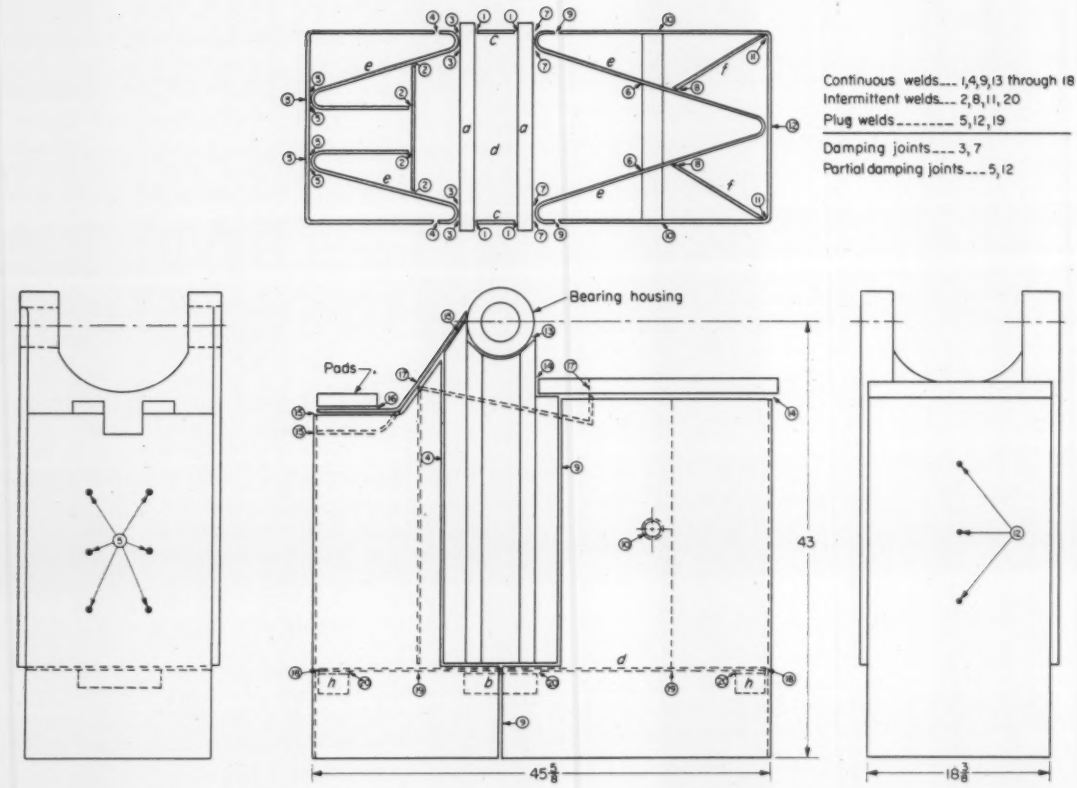

Fig. 5—Assembly and welding drawing for welded base of Bryant internal grinder. Design is based on principles discussed for vibration control. Welding sequence is shown by circled numbers.

for the loop area are in.-lb/in.^{3} (psi × in./in.).

The relationship between vibratory stress and damping capacity for steel and cast iron is represented by Fig. 3. Damping capacity of cast iron is obviously higher than that of steel—but only when the same stress is applied to both materials.

Point *A* represents, as an example, the damping capacity of cast iron for a vibratory stress of ±6000 psi. The same damping capacity can be produced in steel (point *B* on Fig. 3) by increasing the vibratory stress to ±9000 psi. If the vibratory stress in steel can be increased to ±11,000 psi (point *C*), the damping capacity of the steel would be double that of cast iron stressed at 6000 psi.

Thus, to exploit the damping capacity of steel, higher stresses must be used than in cast iron. Generally, this means using thinner walls in a steel structure than in a cast-iron structure. Duplicating a cast-iron design in steel must be avoided.

Less wall thickness means, generally, less

Fig. 6—Half-scale welded-aluminum model used to test adequacy of the design.

weight. This, too, has a beneficial effect on vibration control. It may be remembered, from the discussion of Equation 1, that lowering mass of the structure tends to raise its natural frequency. This, in turn, tends to move the characteristics of the structure further to the left of the "infinite" peak in Fig. 1.

Summary: The practical rules for vibration control in machine structures and bases, and what they mean in terms of welded design, are:

1. Design for rigidity. This is a "natural" for welded design by using closed-box weldments and proper stiffening methods.
2. Develop highest damping capacity. The steel must be stressed to a relatively high level. Other design methods are also discussed in the next section.
3. Design for light weight. Again a "natural" for welded design.

Design Techniques

Design of weldments can also promote practical damping by providing "damping joints" between welded parts. This method, plus previous principles, has been applied effectively in the design of a new internal grinding machine.

Three rules are often mentioned[2] for prevention and control of distortion in welding: (1) reduce shrinkage forces, (2) make them work to reduce distortion, and (3) balance shrinkage forces with other forces. For vibration control, a fourth rule should be added: utilize the shrinkage forces for damping vibration.

This new rule has been followed in the design of the internal grinding machine and has proved very effective in conjunction with the principle of designing for rigidity. The underlying principles are illustrated in Fig. 4. In Fig. 4*a*, a conventional T-fillet is shown which often causes distortion because of shrinkage forces which pull the two sides of the horizontal plate up. This is particularly true in the case of "overwelding."

Sketches *b* and *c* in Fig. 4, on the other hand, represent "damping joints," first conceived by the authors. These damping joints require a particular welding technique and a particular design technique. V-shaped or U-shaped ribs, channels or similar structural shapes are arranged so that the weld produces stresses as indicated by the arrows. The damping joints are especially practical in machine tools where the welds are not easily overstressed.

A damping joint where U-shaped walls are used is shown in Fig.4*b*. The U-shaped walls may be light or heavy gage. Sketch *c* represents a damping joint where a light-gage U-shaped wall is welded to a heavier straight plate. The first type (4*b*) has been used in an experimental aluminum model of the grinding machine; the second one (4*c*) in the final aluminum model and a plastic model, and in the machine itself.

Additional damping is provided in the damping joints by making use of friction at the junction of two members. It has been observed that damping increases considerably when mating parts are in close contact, presumably because of small relative movements of the parts. Close contact has been accomplished by filing a flat on the radius of the bend, by holding the two surfaces tightly together during welding, and by preventing welds from entering the flat. Shrinkage forces pull the flats together, insuring close contact of the sur-

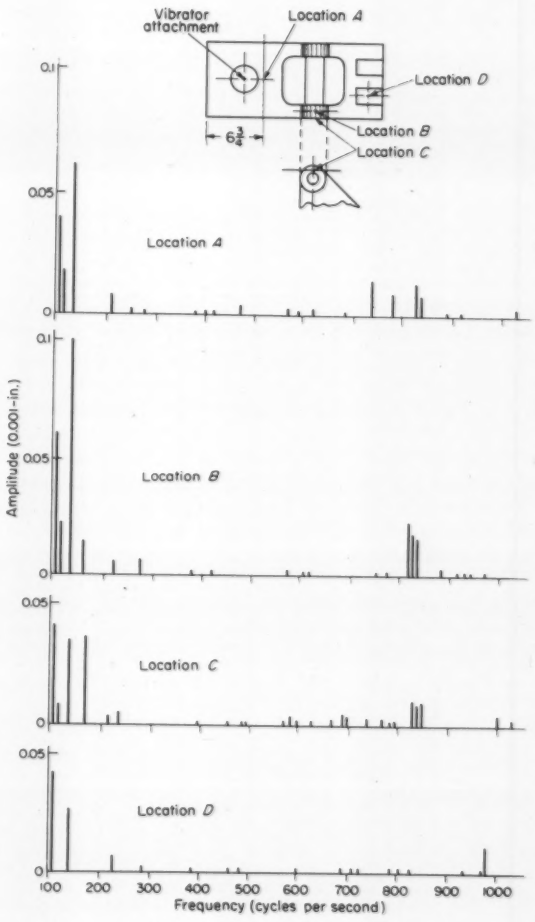

Fig. 7—Results of vibration tests on the aluminum model. Peaks from 100 to 150 cycles per second proved to be caused by the testing setup. No vibrations greater than 0.0000001-in. were encountered from 1025 to 6000 cps.

faces after the welding has been completed and the clamps removed.

Tests on all models and on the actual machine proved that damping joints are very effective in reduction of vibration.

Welded Bed Design: An assembly drawing of the bed design finally adopted for the grinder is shown in Fig. 5.

The center portion of the welded bed supporting the bearing housing, and comprising the plates *a, b, c* and the bottom *d,* was designed as a closed box section—the same as the rest of the bed—for high torsional rigidity and also to establish a node of vibration at the center. For this latter purpose, plates *a* were made relatively heavy.

The top of the right-hand portion of the bed was likewise made of heavy steel to avoid any deformation that might possibly occur when attaching the workhead and other attachments in the operation of the machine. All other parts of the bed are made of ¼-in. sheet steel for the outside covering and 3/16-in. for the internal walls. The entire bed has no openings except for a tube connection, a feature which contributes to high rigidity.

Vertical rigidity is more important in an internal grinder than rigidity in other planes, because misalignment in the vertical plane affects the accuracy of the workpiece most. For this reason, internal walls *e* in Fig. 5 were placed vertically and designed in V-shapes. This design also afforded horizontal rigidity and made possible the damping joints discussed previously. The V-shaped walls were placed with their open ends toward the center portion, first, to obtain two V-bends on either side of the center and, second, for horizontal rigidity and alignment.

Cross walls *f* and *g* were run to the V-shaped walls to eliminate local "drum effects" and to increase the stress for better damping capacity. Pads *h* hold the isolator springs.

Sequence of we'ding is also shown in Fig. 5 by the circled numbers.

Vibration Tests

Two models of the bed of the internal grinding machine were made to half scale by welding aluminum plates and tested on an MB vibrator before the final machine was built. Aluminum was selected for the models to obtain simple relationships between vibration of the model and of the steel bed.

Natural frequency of vibration can be determined from an expansion of Equation 1:

$$\omega_n = K\sqrt{\frac{EI}{ml^3}} \qquad (2)$$

where E = modulus of elasticity; I = moment of inertia; K = constant depending on end conditions (hinged, clamped, etc.); l = length; m = mass; and ω_n = natural frequency.

Instead of the quantities noted, ratios of values for aluminum and steel, and ratios of dimensions of the model and full-size bed, are substituted.

This dimensional analysis of Equation 2 shows that the ratio of the natural frequencies of the aluminum model to the welded steel bed is inversely proportional to the ratio of their length dimension. Hence, when the welded steel bed is twice the linear size of the aluminum model, the natural frequency of the steel bed is half that of the aluminum model. In this way it was possible to predetermine very accurately the natural frequency of vibration of the steel bed.

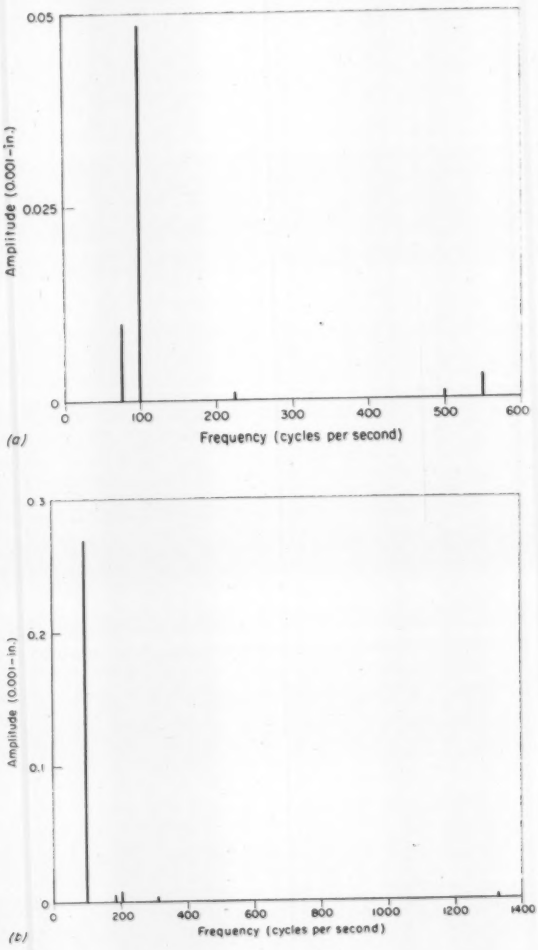

Fig. 8—Tests of solid cast-iron block which proved the testing setup responsible for vibrations in the low-frequency range: *a,* with pickup on top of H-frame supporting the vibrator; *b,* pickup on top of block.

The design of the new grinding machine called for wheel speeds ranging from 5000 to 100,000 rpm and for work speeds from 500 to 1200 rpm. It was decided to build the machine structure so rigid that its natural frequency of vibration would be higher than 100,000 cycles per minute, that is, higher than about 1670 cycles per second, to eliminate the chance of running the machine through resonance when sparking out or when grinding at lower speeds.

The aluminum model corresponding to the final design is shown in Fig. 6. According to the previous analysis, it was necessary to test the aluminum model up to 2×1670 cps $= 3340$ cps in order to cover the entire working range of the actual machine. Actually, the vibrator available was able to go considerably higher with the imposed frequency—specifically, up to 6000 cps.

The vibrator was attached to the model at the point shown in Fig. 7; this point represents the equivalent single fixation for the workhead. Vibrations were measured with an oscillograph, and the pickup was attached to various locations *A* through *D* in Fig. 7.

In location *A*, Fig. 7, the oscillations were picked up at a point as near the vibrator as dimensions permitted. No substantial amplitudes occurred up to 1000 cps, except in the vicinity of about 150 cps. The reason for these amplitudes will be discussed later. The results are plotted only up to 1000 cps although the tests were run up to 6000 cps. No peaks greater than 10^{-7}-in. occurred above 1000 cps which is, of course, a very gratifying result.

Essentially the same results were obtained when the pickup was placed on top of one of the bearing housings (location *B*), on one side of the bearing (location *C*), and on the pad (location *D*).

To investigate the appearance of larger amplitudes near 150 cps, the pickup was placed on the H-frame supporting the vibrator. The same large amplitudes were measured near 150 cps, Fig. 8*a*. Finally, to explore all possible causes, the model was replaced by a solid cast-iron block, and the pickup was attached to the block, Fig. 8*b*. The amplitude at 150 cps was again noted. It was thus evident that the 150-cps peak was not due to the design of the model (and of the bed) but rather to the H-frame supporting the vibrator.

Summarizing, the vibration tests proved that the actual steel bed, when designed according to the principles developed and incorporated into the model, would be free from disturbing vibration amplitudes at least up to $\frac{1}{2}$ (6000) $= 3000$ cps, corresponding to 180,000 rpm. This is 80 per cent better than the target set.

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Tips and Techniques

Locating Decimal Points

AN ACCURATE method of locating the decimal point when multiplying with a slide rule is based upon the use of the characteristics of the common logarithms of the numbers involved. Basically, the system is employed simply by adding the characteristics of each quantity in the numerator and subtracting the characteristics of each quantity in the denominator to obtain the characteristic of the answer. There are two exceptions to the basic method which must be considered.

1. When multiplying, 1 must be added to the characteristic when the *C* scale is moved to the left of the *D* scale in order to perform the multiplication
2. When dividing, 1 must be subtracted from the characteristic when the *C* scale is moved to the left of the *D* scale in order to perform the division.

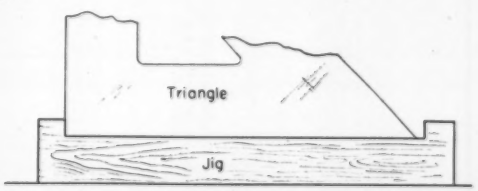
The following example illustrates the use of the method.

$$865 \times 0.0035 = 3.03$$

Addition of the characteristic of 865 (2) to that of 0.0035 (-3) results in a characteristic for the answer of -1. However, the *C* scale was moved to the left of the *D* scale to perform the multiplication which means that 1 must be added to make the characteristic zero. This calls for placement of the decimal point as shown.—HERBERT J. WERNER, *Baldwin-Lima-Hamilton Corp., Hamilton, O.*

Crosshatching Jig

Rapid, equally spaced crosshatching is facilitated by a jig. It may be made of $\frac{1}{8}$-in. hardboard. In use, jig and triangle are alternately moved while the other is held.—FRED J. JARONE, *Lafayette Hill, Pa.*



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By Earlwood T. Fortini, *Mechanical Engineer*
Datamatic Corp., Newton Highlands, Mass.

DIMENSION

Part 7—Practical Considerations in Applying Dimension Control Methods

IMAGINE how few refrigerators, sewing machines, automobiles, vacuum cleaners, and all other products there would be if every part had to be carefully tailored to fit. Dimension control is essential in the design and production of machines made of interchangeable parts.

No invariable line of reasoning can be followed in using dimension control principles. Techniques satisfactory for the design and manufacture of automobiles mass-produced at Detroit will hardly apply to the hand-crafted production of delicate jewelled watches.

Dimension control is essentially an aid to the processes of design—an aid in developing products that are simpler, cost less, and perform as well as, or better than, more expensive designs. Above all else it might be said that dimension control is a discipline for obtaining *accuracy by design*. There are two sides to this problem: (1) making sure that the geometry of the design is satisfactory, inasmuch as variations due to tolerances are concerned, and (2) that correct functional dimensions are used.

Most of this series of articles has been concerned with purely technical considerations. This final article, however, will discuss the application of dimension control in a design program; that is, something about the effective use of dimension control methods, considering available skills and the organization of the design group.

Obtaining Accuracy by Design

In a complex machine, accuracy is not a single problem but a number of separate problems, large and small. These problems, moreover, are very often tied together in complicated ways. For many problems it is usually not practical, or even possible, to set the limits of dimension conditions on the basis of theoretical reasoning alone. Analysis and experiment are good, but time-proved experience is best. The usefulness of a dimension study lies not in replacing experience, but in making the best use of experience.

When definite performance objectives are specified, and these objectives can be translated into dimension conditions, then the task of the designer is clear. In such a case cost, although important, is subordinate to performance. Very definite specifications, for instance, may be written for the performance of a ballistic computer or the runout of a spindle in a grinder.

More often, however, dimension requirements are not specific. Designers are obliged either to design with a certain cost as an objective, or to choose what seems to be the best balance between cost and performance.

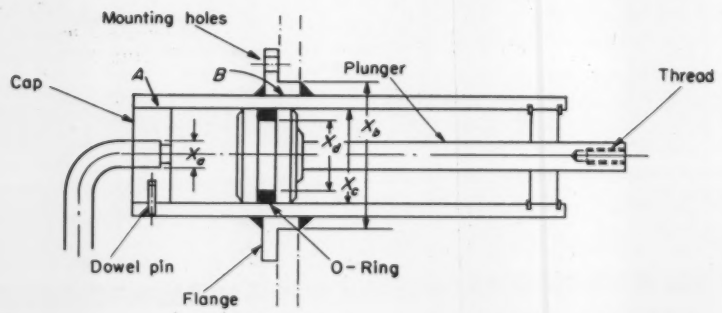


Fig. 37 — Dimensions of a cylinder which must be controlled for interchangeability.

CONTROL IN DESIGN

A systematic study of methods for controlling effects of tolerances and design geometry.

Accuracy, besides having a direct bearing on product performance, has special significance when interchangeable manufacture is involved. Almost every design makes some use of the principles of interchangeable manufacture, but there is great latitude in the degree of interchangeability appropriate for different products. It is meaningless to talk about interchangeable manufacture as if it were a single fixed objective.

Careful attention to the arrangement and proportions of the various parts of a machine often makes the difference between a good design and a poor one. To go one step further, it may be said that the smallest detail of design geometry cannot be overlooked without risking the chance of making dimension control a difficult and costly —if not impossible—problem.

While accuracy can be designed into a machine by observing the proper rules, it is apparent that there are limitations to the degree of accuracy possible. Limitations on accuracy are usually more important in fine instruments and mechanisms than in most other types of mechanical products.

Cost and Performance: With good machine tools, skilled workmen and quality materials, it is possible to hold dimensions with very close tolerances. This fact, however, is not important to the designer who is designing a product that he knows must be produced with worn machines, semiskilled workmen, and inexpensive materials. In order to approach the best balance between cost and performance, the designer must take into account the manufacturing facilities available and select tolerances accordingly.

In theory there is an optimum choice of tolerances. To obtain this optimum choice, a number of conditions must be fulfilled:

1. The design cannot be simplified further.
2. Cost-tolerance relationships for the best choice of manufacturing processes must be known.
3. Design tolerances must be selected that either minimize cost for a given set of tolerance conditions, or maximize the tolerances for a given cost.
4. Production must be statistically controlled.

Some work on the problem of obtaining maximum profit at a given performance level in precision mechanisms has been reported.[5] It should be pointed out, however, that the chances of satisfying the conditions just listed are fairly remote. In the first place, it is impossible to know when a design cannot be further simplified—or when manufacturing techniques cannot be improved. Furthermore, obtaining reliable cost-tolerance data and then carrying through the necessary mathematical analysis is a much more difficult problem than most designers are equipped to handle.

At the other extreme, tolerances can be assigned to satisfy either a fixed cost or fixed performance objective—with no attempt to minimize cost, or maximize performance. This is the case when the

[5]References are tabulated at end of article.

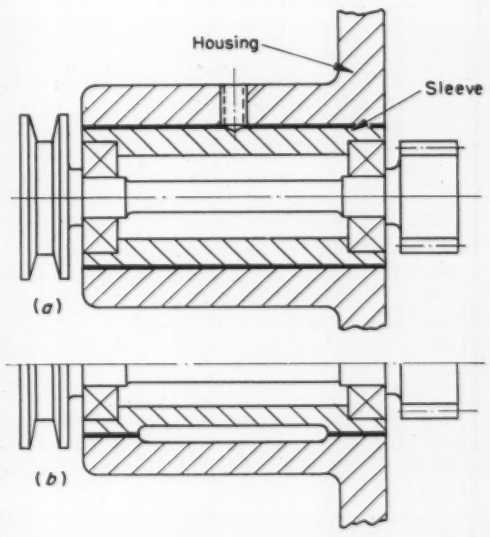


Fig. 38—Method of controlling variations in fit of mating parts at *a* involves limiting the amount of mating surface, *b*.

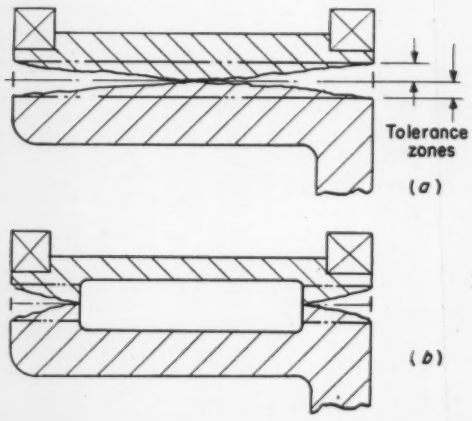


Fig. 39—Why reduction in mating surfaces results in more satisfactory fits. In the original design, *a*, the sleeve can rock; in *b*, its motion is restricted.

nonprobability methods of Parts 3 and 4 are used. Nonprobability methods are desirable when, for instance, few dimensions are involved in a relationship, production is not under statistical control, and a high degree of interchangeability is wanted.

The comparisons made in Part 6, however, show how much greater tolerances calculated by probability methods can be than tolerances worked out by nonprobability methods—especially when the number of dimensions controlling a relationship is more than four or five. Therefore, when tolerances calculated by the methods of Part 4 are unjustifiably close and an optimum tolerance assignment is not practical, the calculation of tolerances by the probability methods of Parts 5 and 6 is a rewarding compromise.

Some element of risk is always involved in probability assumptions. Three kinds of risk can be recognized: (1) theoretical design risk, (2) theoretical manufacturing risk, and (3) the real risk.

When the probability distribution is assumed to be rectangular, the theoretical design risk refers to the combination or assembly of functionally related parts. The risk level may or may not be a conservative estimate of the real risk, according to how close the actual distribution found in manufacture approximates the rectangular. A tendency for dimensions to cluster about the mean will result in a real risk less than the theoretical design risk. On the other hand, if the dimensions all fall close to the limits, the real risk will be greater than the design risk.

For the rectangular distribution, the theoretical manufacturing risk can be treated independent of design risk. Production planners, for instance, may increase process tolerances beyond drawing limits and then reject all out-of-tolerance parts during inspection. Possibly some risk may be assumed if 100 per cent inspection is not practiced. But even though the combination of design and manufacturing risk may show that the acceptance rate for a product will be less than 100 per cent—say 95 per cent—all that may be indicated is that one or more parts in each of five defective assemblies in a lot of 100 need be replaced to bring the acceptance rate up to 100 per cent.

Relationships of normally distributed dimensions are somewhat more involved. The coefficient of risk R, (see Equation 23 in Part 6) includes not only the term u which sets the level of theoretical design risk P, but also the ratio ρ of process standard deviation σ_p to measurement standard deviation σ_m. Furthermore, the tolerance should agree with

$$t = \left(\frac{\sqrt{\rho^2 + 1}}{\rho} \right) \sigma_p$$

It must be recognized, however, that the designer may approach the problem of dimension control with little knowledge of values of ρ and σ_p. His concern may be limited to calling for the greatest practical tolerances possible to control the variation of a dimension condition. His guide may be whatever published tolerance tables are available coupled with a limited knowledge of specific facilities. Even so, this fact does not rule out the potential usefulness of the preceding formula. From the designer's choice of tolerance t, and level of design risk u, production planners can select machines and processes that suit the values of ρ and σ_p for their particular facilities. This indeed may be the most effective application of the formula.

Interchangeable Manufacture: Parts are said to be interchangeable if from a group of similar parts any one can be used in place of any other with equal confidence. It is not enough merely to say that parts shall be interchangeable; what is further necessary is to be able to recognize what must be interchangeable, at what stage of manufacture, and to what degree.

Interchangeable manufacture is a subject that covers a lot of ground. A single example can hardly do more than give a hint of how dimensions are controlled with regards to the requirement of interchangeability. The following illustration is, therefore, quite limited in scope.

Assume that the air cylinder shown in *Fig.* 37 is an interchangeable unit—that is, any cylinder made to the same specifications can be used in place of any other with equal confidence. The confidence demanded determines the degree of interchangeability; in the case of the cylinder, absolute interchangeability could very well be expected. To be interchangeable, the following dimensions would have to be controlled, since these form relationships with mating parts: the diameter x_a of the hole for the air supply tube, the locating diameter x_b, the position and size dimensions of the mounting holes, and the dimensions of the thread.

Interchangeability of the air cylinder may be wanted for two reasons: to facilitate (1) initial installation and (2) replacement.

Component parts of a unit can have varying degrees of interchangeability as required. Because the O-ring seal in the air cylinder is subject to wear, the diameters that control the squeeze of the O-ring should be dimensioned to assure 100 per cent interchangeability. When calculating tolerances for gland diameters x_c and x_d, the designer would have to choose between using either the non-probability methods of Part 4, or the probabilty methods of Part 6. If the limits of the dimension condition (the squeeze on the O-ring) are not absolutely fixed, probability methods would be justified—providing of course that the value of the design risk R were set for a low level.

Replacement is not always a consideration. Interchangeability may be desired because it is an essential factor of an efficient manufacturing operation.

Some components are built up from a number of pieces; a very limited degree of interchangeability is often indicated. The cylinder body in *Fig.* 37, for instance, consists of a tube, a flange, a cap, and a dowel pin. The fits at *A* and *B* could very well be left to the discretion of the shop people. For instance, the hole of the flange could be machined to accommodate the unmachined outside diameter of the tube. The method of obtaining an airtight fit at *A* could be purposely left unspecified to allow the shop the freedom of using either a force or a shrink fit.

Details of Design Geometry: The first and, quite understandably, the most important phase of a dimension study is concerned with fairly obvious aspects of a design: the sensitivity of variations of individual mechanisms on the output of a train, and how hard or easy it is to control the variation of dimension conditions with practical tolerances. The dimension study should not end with these. A final close examination of the details of mating surfaces will prove rewarding in most cases, if not altogether essential in some.

Two precepts can be laid down as guides to the evolution of sound details of design geometry:

1. Limit the amount of mating surface; use only what is really necessary, and no more.
2. Wherever possible, avoid overconstraints.

Both precepts are derived from a single set of principles called *kinematic design.*

An example of how to limit the amount of functional surface to only what is necessary to do the job is illustrated by *Fig.* 38. The advantages of design *b* over *a* are intuitively apparent. These advantages may, of course, be explained by using the idea of tolerance zones. For instance, the functional surfaces could be tapered, *Fig.* 39*a,* resulting in the gear being poorly supported. By elimination of some of the surface, *Fig.* 39*b,* the possibility of an unsatisfactory condition is obviated.

It is not difficult to extend the principle of reducing functional surfaces so that there are no longer surfaces, but "points" in contact. The points are, to be sure, really small surfaces—for a point is not able to support even the smallest load. This theory of locating bodies by points is most commonly called *kinematic design.*[6, 7] The main principle behind kinemetic design is that, for a body to be ideally located, the number of degrees of freedom plus the number of independent constraints is equal to six. The six degrees of freedom are three of translation along the three principal axes, and three of rotation about these same axes. Also presumed are forces acting opposite to the constraints.

As an example, suppose that the ring shown in *Fig.* 40*a* is to be located so that the ring has only one degree of freedom—rotation about the *Z* axis. According to the principle, only five independent constraints should be necessary to locate the body; these are shown in *Fig.* 40*a.* For constraints 3, 4 and 5, the opposite-acting forces are provided by gravity; for constraints 1 and 2, by force *F.*

True kinematic design is applicable mostly to very accurate instruments and mechanisms where forces are light. A modification of the principle, known as semikinematic design, is generally better suited to the ordinary problem. The difference is that points are replaced by areas, and some exception may be made to the rule which says that the number of degrees of freedom plus the number of independent constraints should add up to six. An example of the ring located semikinematically

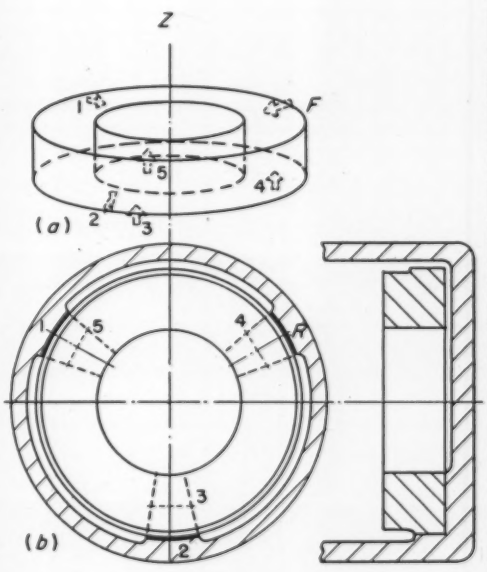


Fig. 40—Idealized support, *a,* for a ring to allow rotation about the *Z* axis; the five numbered points, force *F,* and gravity provide the necessary constraints. An equivalent construction, *b,* replaces the five numbered points by the numbered pads, and force *F* by the unnecessary constraint, *R.*

is shown in *Fig.* 40*b*. Here, opposite-acting force F is replaced by an extra constraint, R.

The significance, as far as dimension control is concerned, of reducing the size of functional surfaces to small areas can be illustrated by *Fig.* 41. By mere reduction of the amount of surface, the possibility of extreme dimensions occurring is correspondingly reduced.

Limitations of Accuracy: Even with the most careful attention given to overall planning and to the details of design, there are limitations beyond which no further accuracy is possible. Several factors that determine these limitations are:

1. Operation of the machine or mechanism.
2. Materials used in its construction.
3. Manufacturing processes.

The first two items determine what dimensional instability should be expected; that is, the change in dimension of a part after it has been manufactured. Dimensional instability is due to thermal effects, unstable constituents in materials, applied stresses, wear and corrosion. These can cause bearing preloads to change, make shrink and press fits relax, alter the backlash in gear trains, bend shafts, damage wear surfaces, etc.

Limitations on accuracy of the manufacturing process are involved with the inherent precision of individual machines and processes, the environment and operation of the plant, skill of the working force, and the inherent errors in the accuracy and use of measuring instruments.

Some idea of the possible magnitude of dimensional inaccuracies is given in *Fig.* 42. For the particular data assumed, the ratio of process deviation to deviation from all other sources, $\rho \approx 3$. This figure is fairly representative of many design circumstances.

Organizing a Dimension Control Program

More often than not engineering design is done by a group of specialists; the ability of the group to work as a team demands good co-ordination of technical and organizational considerations. Dimension control, to be sure, is only one technical consideration. There is an advantage in having an engineer whose duty it is to advise on dimension control problems. Depending on the nature of the work, and the size and composition of the engineering staff, this may or may not be a full time job. A large organization may find it necessary to retain a small section. Not the least important reason for bringing all dimension problems to a single person, or group, is to expedite the use of cost and time-saving standards.

Design Steps: A parallel could be drawn between a strength study and a dimension study. In a strength study, as parts are proportioned, the distribution of loads determined, and stresses and deflections calculated, the design is progressively reshaped and modified. In a dimension study, as the design takes form and dimensional relationships become apparent, the effects of tolerances are investigated and, as in the strength study, the design is changed until a satisfactory arrangement is obtained.

Here the parallel ends. A strength study is finished when the size and shape of the parts have been satisfactorily worked out and materials specified. The end results of a dimension study, however, are dimensions for detail drawings. Until drawings are made and appropriately dimensioned, the job is not done.

The time to begin thinking about the effects of tolerances and design geometry is early enough so that modifications do not make a lot of detailed work worthless. Only when a designer is convinced

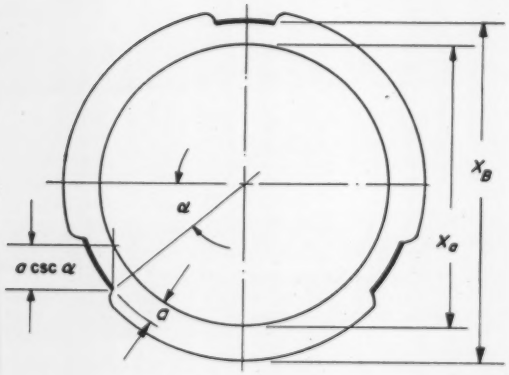
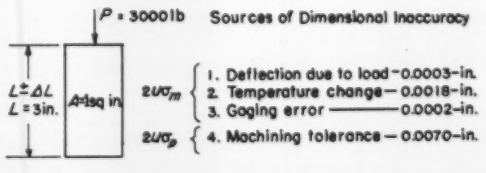


Fig. 41 — Left — Clearance for a three-land hole, which is greater than for a plain hole having the same effective dimensions.

Fig. 42—Below—Factors affecting dimensional accuracy: operational, environmental, metallurgical and manufacturing conditions.



that an idea is satisfactory in regard to the control of dimensions, and that no significant improvement seems possible or worth the effort, should he stop looking for improvements.

A logical order of steps in a dimension study might, for instance, be:

1. Recognize the problem—locate functional relationships and specify the limits of dimension conditions.
2. Formulate the problem and then proceed to assign tolerances to suit.
3. Work out dimension limits and have these transcribed on to the appropriate detail drawings.

These three steps will require, depending of course on size of the job and organization of the engineering staff, more or less elaborate methods for recording, transmitting, and checking information. It is not unusual that the efforts of a single designer could result in the need for preparing several hundred drawings involving well over a thousand functional dimensions. If the drawings are prepared by a number of draftsmen it is easy to see that very careful organization and planning are needed.

Standards: When there are a number of ways of doing something, and by common agreement one way is decided on for everyone to follow, then a standard is established. Standards are set up by international and national agencies, by associations representing particular industries, or by companies. Standards concerned with dimension control include: (1) dimensional standards for common mechanical elements like gears, splines, keys and keyways, cylindrical fits, screw threads, etc., and (2) standard tolerances for the ordinary manufacturing processes when specific data are not available.

Because of the differences in manufacturing practice for various kinds of products and types of industries, standards are by no means universally applicable. The job of evaluating and selecting—or creating—useful dimensional standards should be one of the most important duties of any engineer or design section concerned with dimension control.

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Extra Copies

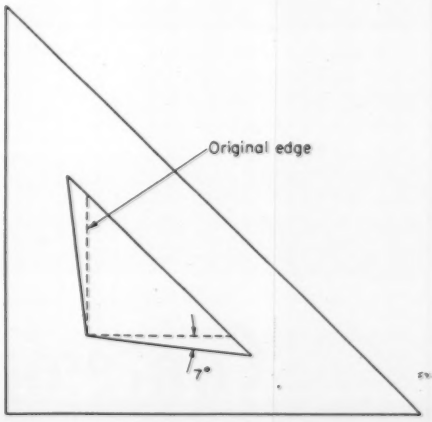
Reprints of this series of seven articles, "Dimension Control in Design," by Earlwood T. Fortini, are available for $1.00 each from: Reader Service Dept., *Machine Design*, Penton Bldg., Cleveland 13, O.

Tips and Techniques

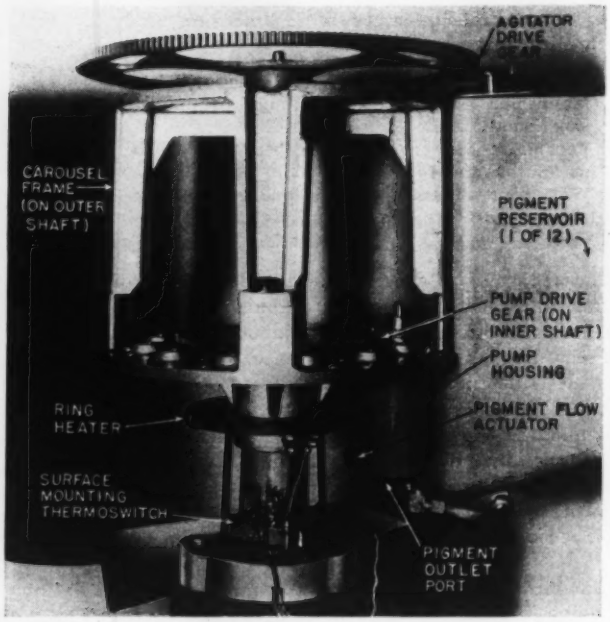
Drawing Draft Angles

PARTS to be made by processes such as die casting, forging or plastic molding usually require specific draft angles. Since these angles cannot usually be drawn with an ordinary triangle, constant adjustment of the protractor of the drafting machine is necessary.

To avoid this annoying adjustment, modify a triangle as shown in the accompanying sketch. A portion of the material is removed from the center portion to form the desired angle. In this case, the triangle has been modified to provide the standard 7-degree draft angle for forgings.—ERNEST H. SCHAFFERT, *Electrol Inc., Kingston, N. Y.*



MACHINE MIXES PAINT TO SPECS



CAREFUL control of temperature and thereby pigment viscosity permits accurate blending of colored paint to meet buyer requirements in a recently developed machine. Reservoirs for the 12 pigment shades are colored to match the pigments they contain and are mounted upon a frame which rotates continuously when paint is not being tinted. This results in the name Color Carousel. The machine is manufactured by Color Carousel Corp., an affiliate of Standard-Toch Chemicals Inc.

To fill an order the six control dials are set to select the desired pigments and quantity. Dials in the upper row select the reservoirs by letter from *A* to *L*. Dials in the lower row are timers calibrated in units of 1 to 60. The machine then automatically stops when each of the selected reservoirs is in position above the can of base stock and the selected quantity of pigment is delivered. In order to maintain a constant quantity of pigment for a given pump operating time, the viscosity of the liquid pigment must be maintained at a nearly constant value. This is done by maintaining a nearly constant temperature.

Method of operation is shown by skeleton structure with all but one pump and one reservoir removed. Two separate drive systems are mounted on concentric shafts. When not mixing, the frame on which the pumps and reservoirs are mounted is slowly revolved by the outer shaft. A large agitator drive gear on top of the frame drives agitators in each of the tanks. The pump drive gear on the inner shaft is stationary but since the pump driven gears are in mesh with this gear, they are driven slowly as the frame revolves. This circulates pigment through the pumps and reservoirs at about 3 oz per minute. Heating of the pigment when necessary occurs in the cast-iron pump bodies which are close to the 5-in. diameter, 250-w ring heater.

A feeler arm located at the front of the machine near the position in which pump and tank must be located to deliver pigment to the can of base stock is constantly closing one of 12 small snap-action switches corresponding to the pumps and reservoirs. When selector dials are set, a circuit can be completed through the selector switch by the operation of the small snap-action switch. This de-energizes the Carousel drive motor to stop rotation at correct delivery position and starts the pump drive motor and timer. An actuator arm operates the plunger on the side of the pump to close the recirculating line and open the delivery port at the bottom of the pump at the same time. When the selected time has elapsed, the timer opens the circuit, plunger is released and Carousel motor started to repeat the process for other selected pigments.

Contemporary Design

Nomographs aid design of

Hydraulic Pumps and Motors

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DESIGNING hydraulic units to satisfy certain flow rate requirements is often a trial-and-error process. Charts presented in this article have been designed to speed such calculations for gear, vane and piston type units.

Theoretical flow rate Q is a function of certain linear dimensions of the pump or motor and its speed. These characteristics are identified in the Nomenclature. The well known equations for theoretical flow rate are presented in Table 1. These equations are solved graphically by the alignment charts of Figs. 1 to 3.

Actual flow rate, of course, is determined by multiplying the theoretical rate by the volumetric efficiency.

The following numerical examples demonstrate use of the charts:

Example 1, Gear Type: Find theoretical flow rate Q if speed N = 1200 rpm, gear width F = 1.3 in., gear diameters D_o = 3 in. and D_w = 2.2.in. Then, $D_o + D_w$ = 5.2 and $D_o - D_w$ = 0.8-in. Next, in Fig. 1, join 1200 on the N scale with 1.3 on the F scale by a straight line. Connect the point intersected on scale A with 5.2 on the $D_o + D_w$ scale, and finally join the intersection on scale B with 0.8 on the $D_o - D_w$ scale. The intersection on the Q scale shows that the theoretical flow rate is 22.2 gpm.

Example 2, Vane Type: Find Q for housing bore D = 6 in., eccentricity e = 0.03 in., housing width F = 3 in., and speed N = 1500 rpm. In Fig. 2, connect D = 6 with e = 0.03, and obtain intersection on A. Connect this point with N = 1500 and find intersection on B. Connect this point with F = 3 and read Q = 22 gpm. For a balanced-vane unit having the same dimensions, the answer is doubled, or theoretical rate Q = 44 gpm.

Example 3, Piston Type: Find Q for piston diameter d = 0.5-in., eccentricity e = 0.2-in., number of cylinders n = 6, and speed N = 1500 rpm. In Fig. 3, connect e = 0.2 with N = 1500, and obtain intersection on A. Connect this point with n = 6 and obtain intersection on B. Connect this point with d = 0.5 and read Q = 3.1 gpm.

Nomenclature

Q = Theoretical flow rate, gpm
e = Eccentricity (½ stroke), in.
N = Speed, rpm
n = Number of cylinders
F = Gear face width or vane housing width, in.
D = Vane housing bore diameter, in.
D_o = Gear outside diameter, in.
D_w = Gear working-depth diameter, in.
d = Piston diameter, in.

Table 1—Theoretical Flow Rates for Pumps and Motors

Gear Type, Fig. 1:

$$Q = \frac{\pi}{924} (D_o - D_w)(D_o + D_w) FN$$

Vane Type, Fig. 2:

$$Q = \frac{1}{36.8} DeNF$$

Flow rate Q must be doubled for balanced vane pumps.

Piston Type, Fig. 3:

$$Q = \frac{\pi}{462} d^2 e Nn$$

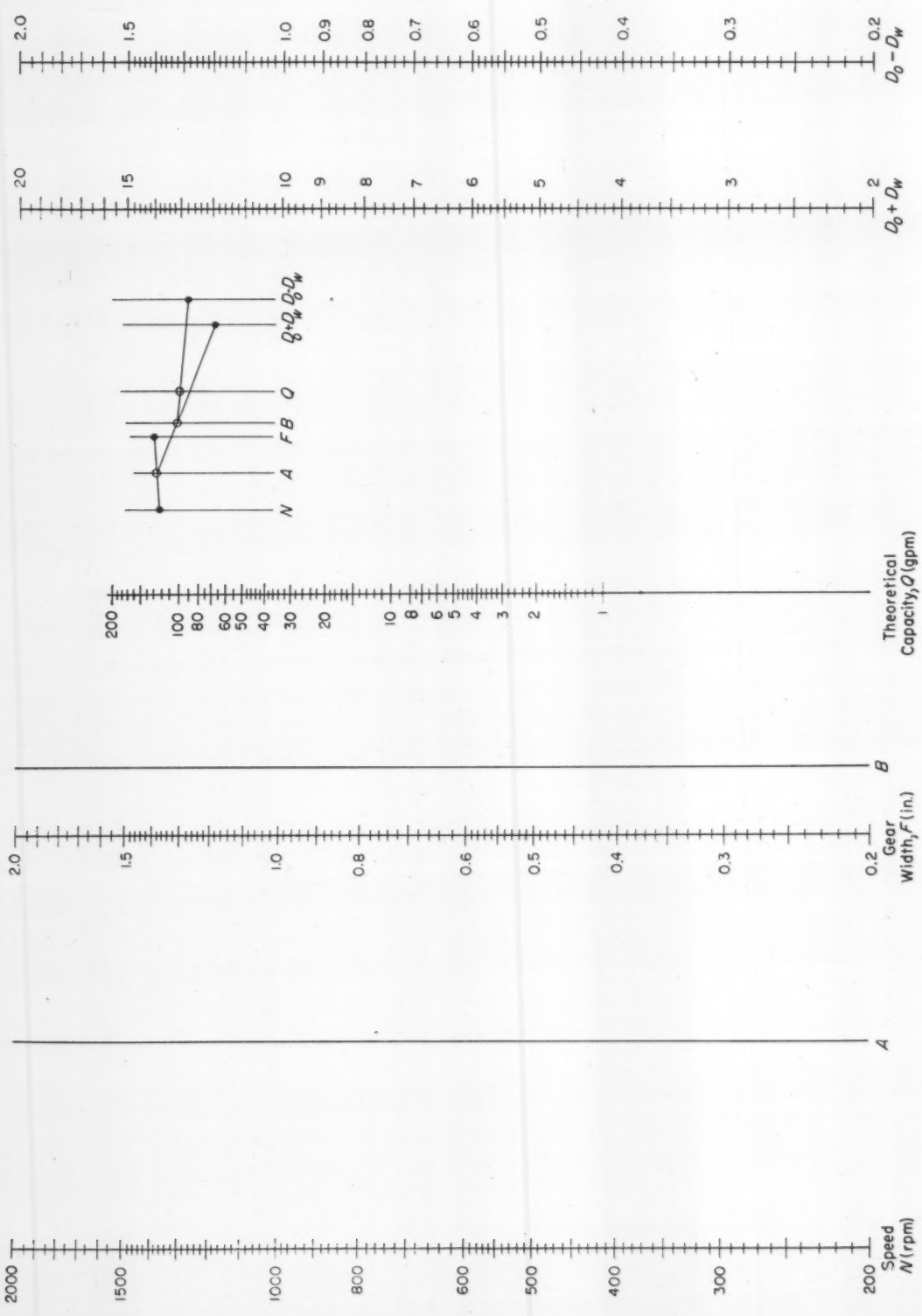


Fig. 1—Alignment chart for gear pumps or motors.

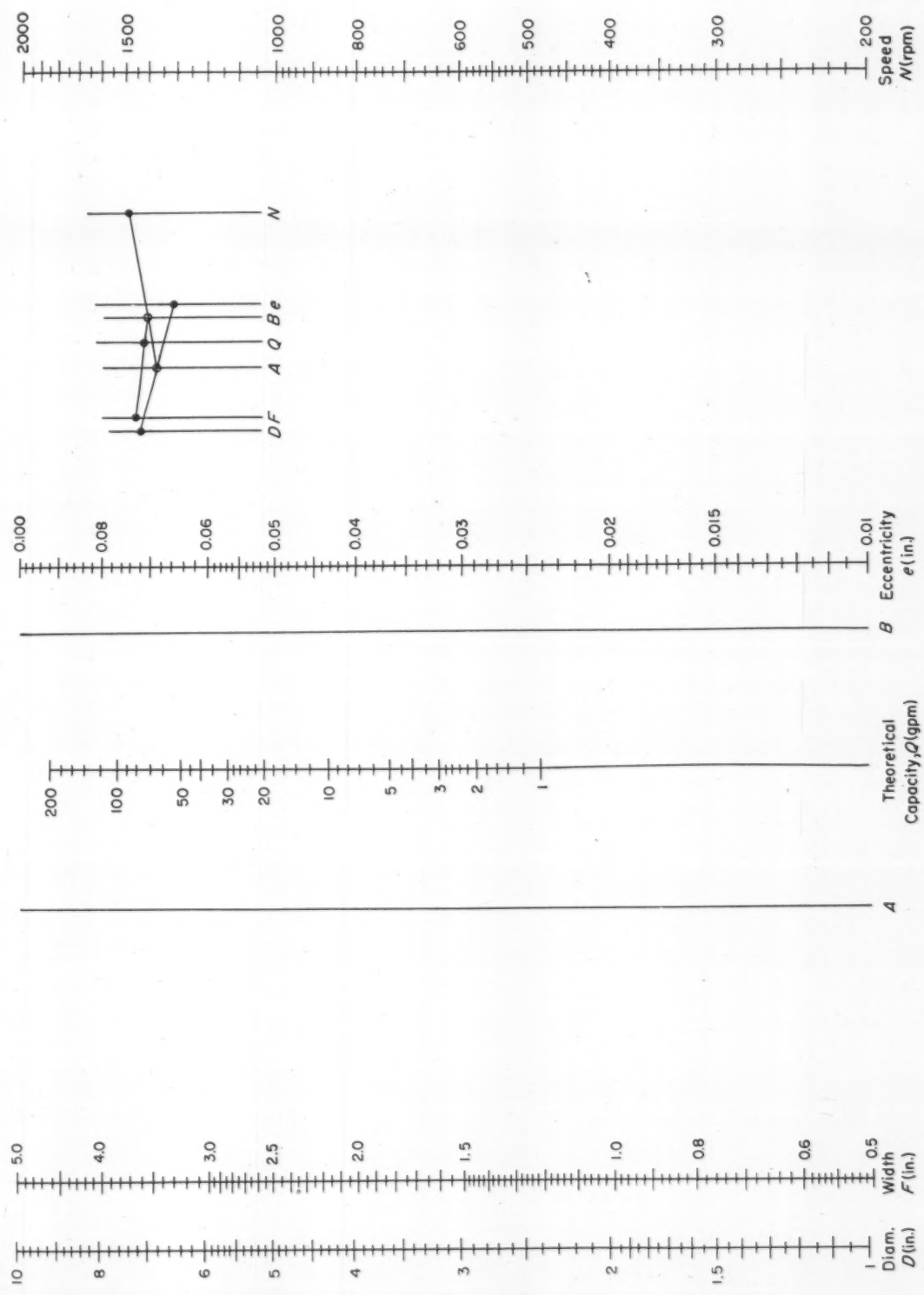


Fig. 2—Alignment chart for vane pumps or motors. Flow rate Q must be doubled for balanced vane units.

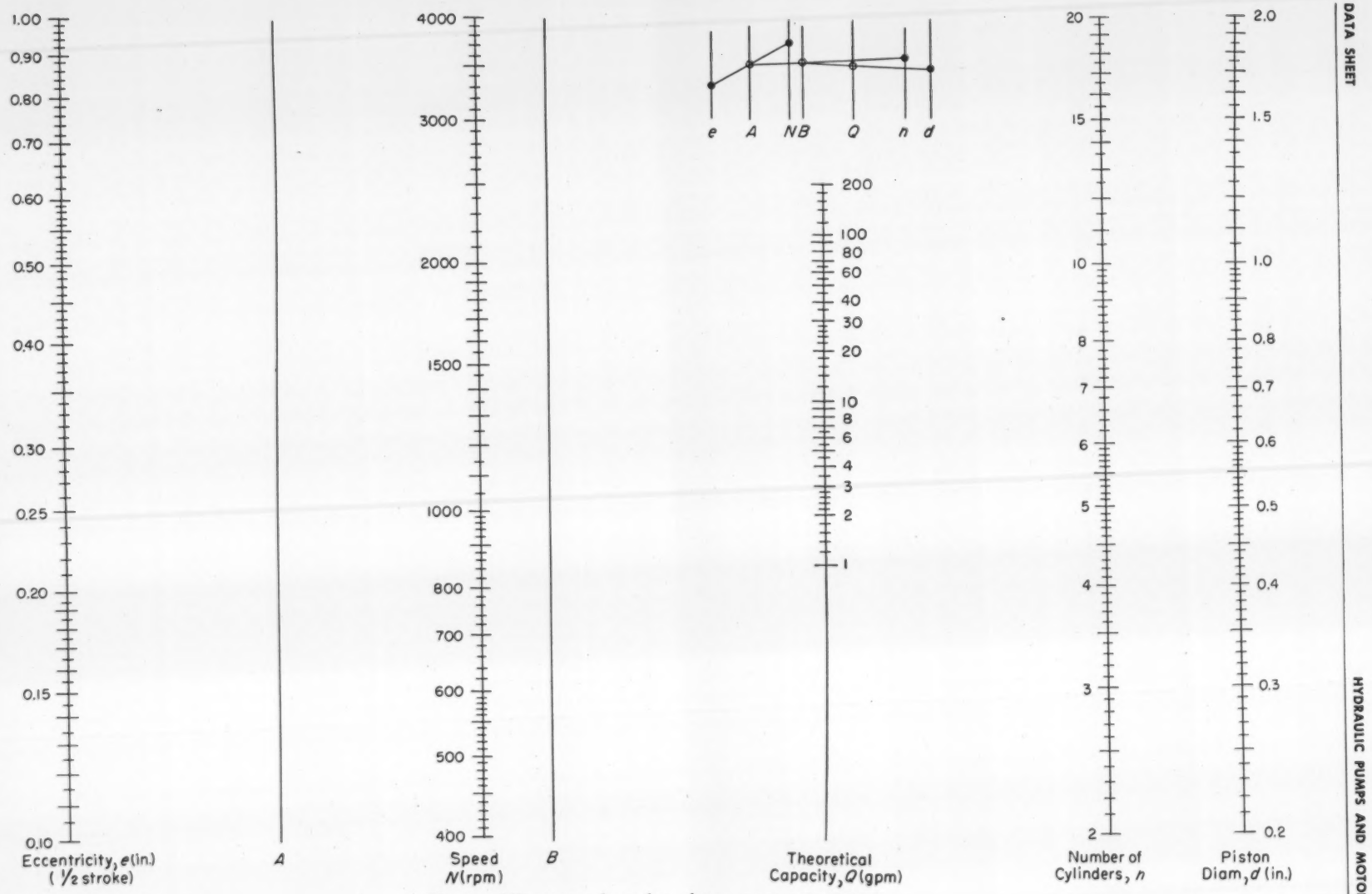


Fig. 3—Alignment chart for piston pumps or motors.

DESIGN ABSTRACTS

New NEMA Standards for AC and DC Motors

By M. E. Knudson
Motor and Control Div.
Westinghouse Electric Corp.
Buffalo

MANUFACTURERS are now completing motor designs that incorporate new NEMA standards for ac and dc motors. From the motor buyer's point of view, this extension of standards will not cause the problems encountered previously when new frame diameters and mounting dimensions were introduced for smaller frames. No new diameters or frame mounting dimensions will be introduced.

AC Motors: The new standards are actually an extension of standards which cover ac motors rated from 1 to 30 hp in frames 182 through 326 which have been in wide use for the past two years. The new extended standards will cover frame sizes from 364 through 445, which represent, roughly, ac motors from 40 to 100 hp, and will be limited to a reassignment of ratings, horsepower and speed.

For dripproof ac motors, a simple and practical rule of thumb for determining the new frame for a given horsepower rating is that the new frame size is two frame sizes down from the conventional size. However, this rule does have an exception; it does not apply to dripproof motors in two-pole, 3600-rpm ratings. Totally-enclosed fan-cooled motors do not follow any such convenient pattern, even though comparable reduction in frame sizes have been made. The most convenient way to relate their old and new frame sizes is to refer to Table 1.

The reassignment of frames has not made any changes in NEMA performance standards, Fig. 1. Standards which set the limits on starting torque, pull-out torque, in-rush current, temperature rise, and other characteristics have not been changed. A dripproof motor for 60-cycle operation will still be rated on a 40-deg rise and enclosed motors on a 55-deg rise. Thus, the new standards will not affect interchangeability. There will be no difficulties in converting from the present standard frame, diameter, and mounting dimensions to the new rating, Fig. 2.

Doubtless there will be many cases in which the new standards will provide an answer to a redesign problem. Possible examples are the problems created by the current trend toward increased cutting speeds and duty cycles on machine tools, and the necessity

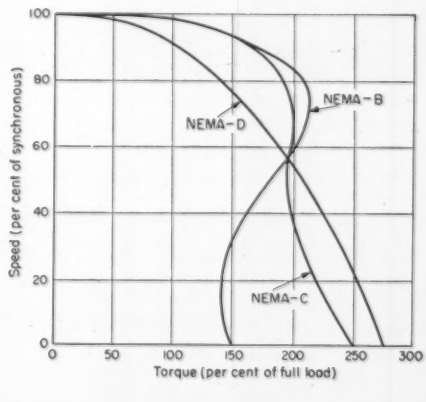


Fig. 1—Typical speed-torque curves for NEMA motors, designs B, C and D.

for increased horsepower requirements for spindle, table and feed motors. In the past, to avoid design changes resulting from space limitations, Class H or silicone-insulated motors rated with high-temperature rise have been used to obtain the necessary increased horsepower. Motors built according to the new NEMA standards can ease this problem; where a 50-hp, 1800-rpm spindle motor was used formerly, it is now possible to use a four-pole, 75-hp motor without any change in mounting or space requirements.

DC Motors: New NEMA standards have also been adopted for *industrial* dc motors, Fig. 3, in ratings of 1 through 200 hp and for generators rated through 150 kw. However, the new standards for dc equipment involve several important changes in ratings and performance characteristics; they cover much more than frame assignments. In fact, under the new standards there are to be no standardized frame assignments.

These changes have been made because the field of application for dc motors has changed materially since original standards were established. Formerly, they were applied for constant-speed drives and wherever direct current was the main source of supply. Occasionally, they were applied to obtain the higher-than-base speeds made possible by weakening the field. At the present time the great majority of dc motors are applied on variable-voltage drives and have their own generator source. Recognition of this trend has resulted in new standards that combine the present constant-speed and adjustable-speed ratings into one design. They also incorporate other important changes that will make dc motors more suitable for their present-day applications.

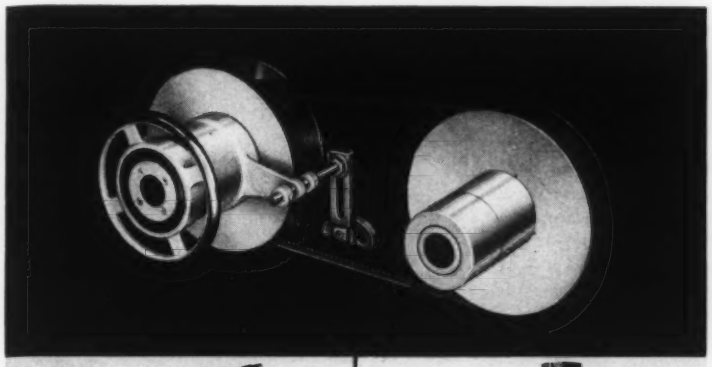
As one of the changes under the new standards, these dc motors will now be known as *industrial dc motors,* rather than by their previous name, *general-purpose dc motors.* This change was made because it was felt that the term "general-purpose motor" had become thoroughly associated with ac motors. Since standards for dc motors are now to be substantially different, the new name was adopted to show this difference.

Principal changes in the dc motor standards can be summarized as: 1. There are to be no frame assignments. 2. A single table of ratings combines the present constant-speed and adjustable-speed ratings; the table provides for 156 ratings, rather than 502 as before. 3. The new motors have improved dynamic characteristics. 4. Nominal voltage is to be 120 and 240 v rather than 115 and 230 v. 5. Class B insulation has been standardized. 6. Dripproof motors may be rated 60-deg C rise with service factor.

To elaborate on this summary, frame assignments set forth in the NEMA handbook for dc motors were actually rescinded by NEMA some time ago, when it was felt that this practice had outlived its usefulness. Therefore, rescinding these assignments under the new standards represents no real change in policy. It was concluded by NEMA that ac and dc motors were not used interchangeably and that since dc applications were usually of a special nature, there

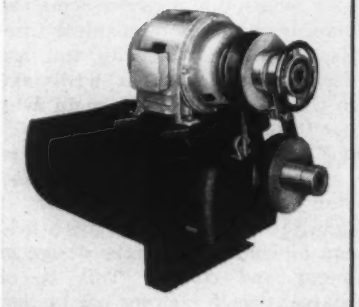
Table 1—New NEMA Frame Assignments for AC Motors

Rated Hp	Rated Speed — 3600 rpm	1800 rpm	1200 rpm	900 rpm
	Open Enclosure—40 C—60 cycles			
		Designs A & B		
20	284	286	326	364-U
25	286	324	364-U	365-U
30	324	326	365-U	404-U
40	326	364-U	404-U	405-U
50	364-S	365-S	405-U	444-U
60	365-S	404-S	444-U	445-U
75	404-S	405-S	445-U	....
100	444-S	444-S	....	....
125	445-S	445-S	....	....
	Totally Enclosed, Fan Cooled—55 C—60 cycles			
		Designs A & B		
20	284	286	326	364-U
25	286	324	364-U	365-U
30	324	326	365-U	404-U
40	....	364-U	404-U	405-U
50	....	....	405-U	444-U
		Design A		
40	364-S	....	....	....
50	365-S	365-S	....	....
60	405-S	405-S	444-U	445-U
75	444-S	444-S	445-U	....
100	445-S	445-S	....	....
	Design D Open—Proposed			
		5-8 per cent slip		
15	....	....	....	364
20	....	....	364	365
25	....	....	365	404
30	....	364	404	405
40	....	365	405	444
50	....	404	444	445
60	....	405	445	....
75	....	444	....	....
100	....	445	....	....
		8-13 per cent slip		
15	....	....	....	365
20	....	....	365	404
25	....	364	404	405
30	....	365	405	444
40	....	404	444	445
50	....	405	445	....
60	....	444	....	....
75	....	445	....	....

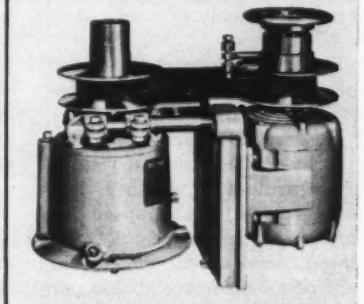


Perfecto Straightener and Feeder incorporates size 308 Combination Pulleys to provide 7 to 63 r.p.m. stock speeds.

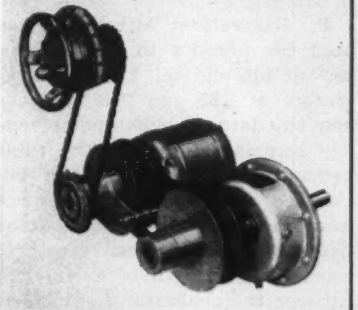
Romulus three-dimensional tracer type Milling Head incorporates size 310 Combination Pulleys, providing 200 to 1800 r.p.m. spindle speeds.



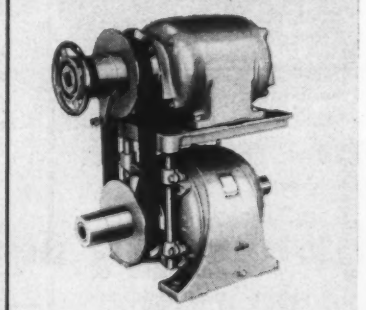
With Meder screw conveyor driver



With Foote Vari-Mount Reducer—vertical or horizontal flange installation



With Falk shaft-mounted reducer—including Dial indicator



With Foote Vari-Mount Reducer—horizontal foot-mounted installation

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Where there are two parallel shafts—usually a motor and machine shaft—apply variable speeds by directly connecting the two with LEWELLEN COMBINATION PULLEYS.

Combination Pulleys are versatile power components—perform smoothly and dependably—operate in any position—require no supporting brackets—include convenient controls and accessories.

Handwheel of one Pulley regulates pitch ratios of both Pulleys at fixed shaft centers. Range of speeds is the multiple ratios of both Pulleys.

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speed ranges to 10:1
selection of center distances
selection of operating speeds

offer widest latitude for directly applying variable speeds.

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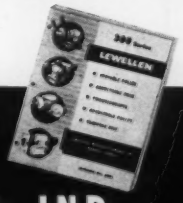
Foote Bros. Vari-Mount Reducers are now catalogued for selection of ratings, service factors, speed ranges, and output speeds.



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was no advantage in having manufacturers of dc motors build their ratings on the same frame sizes. However, it was agreed that generally the frame numbers used with ac motors would continue to be used on the new line of dc motors. The ratings, however, would not fall necessarily on the same frame sizes with all manufacturers.

It was recognized that the torque produced by a dc motor can be much greater than that of an ac motor of the same rating. It should be understood that a 10-hp dc motor, as an example, may be built on one frame size by one manufacturer and on another frame size by another manufacturer. However, with but few exceptions both will have frame numbers that will line up basically with the NEMA numbering system for ac motors.

A single table of ratings came about because of a new approach to the rating of adjustable-speed motors. Under the old system for rating adjustable-speed motors, it was established that an open motor should operate at 150 per cent above its base speed with a 40-deg rise. The motor was also rated at the base speed for one hour at a 50-deg rise. The horsepower was tapered, increasing from that at 150 per cent of speed to that at 300 per cent of base speed, and with a 40-deg rise. This rating at 300 per cent of base speed was the next higher horsepower rating, and varied considerably over the line of motors. The adjustable-speed motor on the old line-up was therefore a somewhat different motor than one designed to operate continuously at base speed with a 40-deg rise.

In the new industrial dc motor the constant-speed and adjustable-speed ratings are merged. Drip-proof motors will operate continuously at base speed with a rise of 60 deg regardless of whether they are sold as adjustable-speed or constant-speed motors. Adjustable-speed motors will carry 115 per cent of their rating at 150 per cent of base speed. At three times base speed, or higher, they will carry 130 per cent of the rating at base speed. Both of these ratings are at 60 C rise, continuous.

The relative response of the new line, Fig. 4, compares very favorably with that of the old. Use of Class B insulation and a longer core length for a given armature diameter reduces mechanical inertia materially. Basically, the new designs have a slight advantage in time constant of the main field, but it should be noted that this is not truly significant because in any case where a low time constant is desired, the relation of inductance to resistance of a field can be controlled by the design of motor and control. This is, of course, true for either old or new machines.

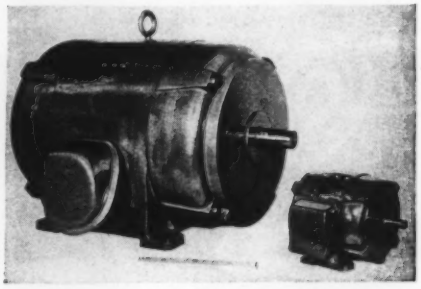


Fig. 2 — Largest and smallest rerated ac motors consisting of a 150-hp motor in the 445 frame and a 1-hp motor in the 182 frame.

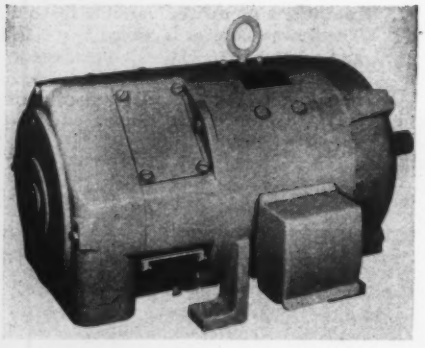
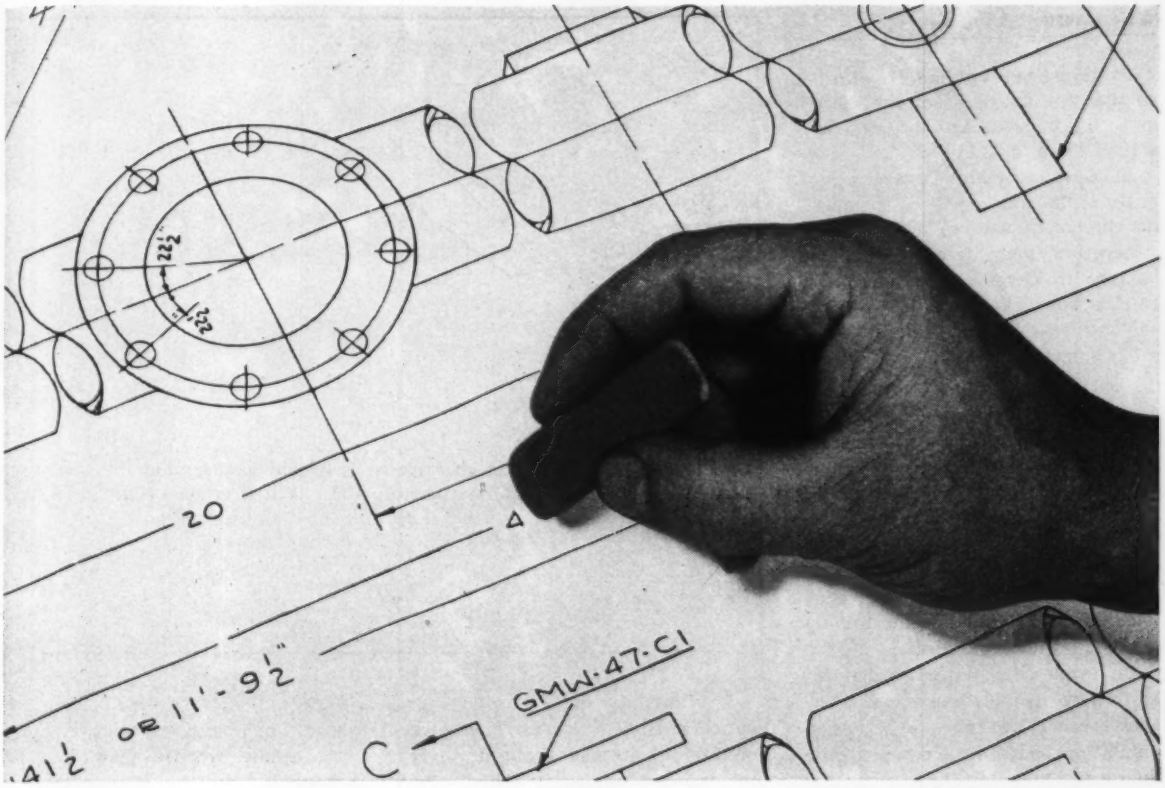


Fig. 3—Industrial dc motor designed according to new NEMA standards.

DC Generators: Although it has been the practice to rate dc motors at 115 and 230 v and dc generators at 125 and 250 v, under new standards nominal motor voltage becomes 120 and 240 v, while generator voltage ratings are unchanged. Earlier, the difference was intended to compensate for line drop, as there was usually a considerable length of conductors between the generator and motors. This situation is not true for the individual variable-voltage drive where the motor-generator set is usually located near the dc driving motor. In such cases, the line drop is negligible. Furthermore, in applications where motors are supplied from a constant potential line, it has been found that users



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have improved voltage regulation so that the average voltage at the motors is more nearly 120 and 240 v than 115 and 230 v.

In considering standards for generators, it was decided to make no change in voltage because new generators very frequently must operate in parallel with old ones. Furthermore, keeping line voltage the same as before brought forth no problems involving capacity of lines.

Insulation: Regarding Class B insulation, the principal advantage of its use is that over the entire range it makes possible smaller motors with lower wk^2 of the armature and lesser fields. This causes motors to be faster electrically. A second reason for interest in this insulation is that a definite user demand is evident for motors with this insulation. Further, recent advances in Class B insulation—such as enameled conductors—have much significance for the new designs.

The ASA Standard for Class B insulation is for a 70-deg rise over a 40 C ambient temperature for an open or self-ventilated motor. The corresponding limit for Class A insulation is a 50-deg rise over a 40 C ambient temperature. Since general-purpose motors were assigned a 40-deg rise (with a service factor) it was thought advisable to use a similar margin for the new industrial dc motors. The present revision of the ASA C50 standards shows a 60-deg rise for Class B insulated motors for general purpose applications. It was desirable, therefore, to maintain the same relationship when using Class B insulation, as had formerly been done with Class A insulation. The same service factor, 1.15, applies to the new line of motors having the 60-deg rise.

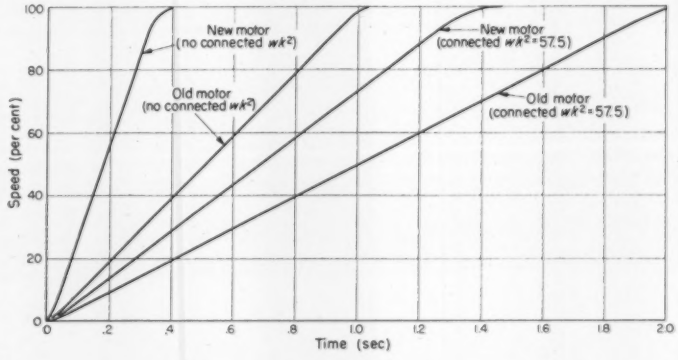


Fig. 4—Dynamic characteristics of old and rerated industrial dc motors, assuming field excited at zero time, current limited to 1.5 times full load, and inertia (wk^2) of 57.5 in old motor and 19 in new motor.

From a paper entitled "The Significance of New NEMA Standards for DC Industrial Motors and Extended NEMA Standards for AC Motors" presented at the 20th Annual Machine Tool Electrification Forum, sponsored by Westinghouse Electric Corp., in Buffalo, April, 1956.

Design factors for

Extruded Rubber

By Thomas O. Mathues

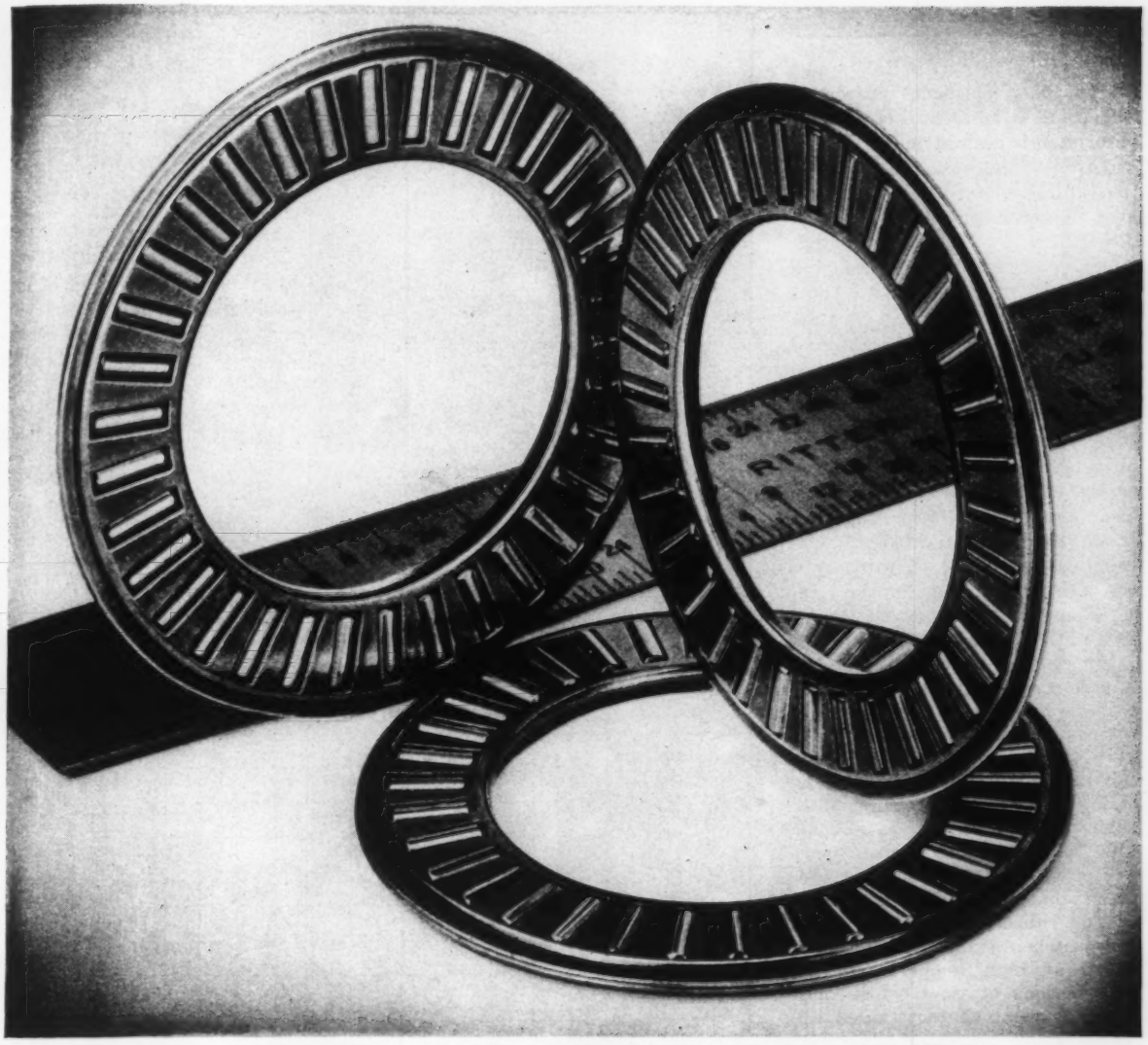
Inland Manufacturing Div.
General Motors Corp.
Dayton, Ohio

THE extrusion process makes possible the fabrication of many rubber products of intricate cross section. Fig. 1. shows a few cross sections of rubber products which are fabricated by extrusion at Inland Manufacturing Division.

Briefly, the process of fabricating rubber products by extrusion involves a rotating tuber screw which forces a rubber compound through an extruding die having an aperture shaped to produce the desired cross section.

Rubber Compounds for Extrusion: Rubber compounds used for extruding contain whatever pigments, age resistors, accelerators, or other ingredients the product requires. Some extrusions, such as refrigerator door sealing strips, must be made from rubber compounds that are tasteless, odorless, and of suitable color. Other extrusions must be made from rubber compounds which have good resistance to oils, sunlight, heat or chemicals.

Natural rubber, GR-S, neoprene, buna N, polyacrylate, and silicone are rubber-like polymers which can be extruded satisfactorily into a variety of cross sections. Natural



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rubber has excellent properties whenever a minimum of energy absorption is desired and long flexing life is required. GR-S (government rubber-styrene), a synthetic rubber developed during World War II, has good abrasion and oxidation resistance properties and has excellent resistance to hot-water swelling. Neoprene has excellent resistance to sunlight and good resistance to oils, heat, and aging. Neoprene also has excellent adhesion to woven fabrics. Silicone rubber, made from silicon, oxygen, hydrogen, and carbon, possesses extraordinary heat resistance and is used for extrusions which will be subjected to elevated temperatures. Silicone rubber also remains flexible and resilient down to a temperature of − 70 F.

In general, hard-rubber compounds can be extruded to thinner sections more easily than soft-rubber compounds, and low and medium tensile-strength compounds can be more easily extruded than high tensile-strength compounds. High tensile-strength extrusions, over 2000 psi, can be made more easily from natural rubber or neoprene than from the other synthetic rubber compounds. Silicone rubber extrusions must be baked at high temperatures for long periods of time before optimum physical characteristics can be realized.

Hardness of a rubber compound is measured by an instrument called a Shore durometer. The maximum "A" durometer hardness of rubber compounds for easy extrusion is around 85 and the minimum is 45, plus or minus 5. Generally, rubber compounds below a hardness of 45 must be supported on special forms until vulcanized.

The effect of the majority of factors affecting the extrusion of rubber products is a matter of judgment for experienced rubber technologists. Certain factors, however, can be related to each other and to the effect they produce on extrusions. In this connection, a chart developed at Inland Manufacturing relates hardness, tensile strength, and allowable dimensional tolerances to the practical minimum thickness which can be satisfactorily extruded, Fig. 2. The values shown on the chart are for rubber extrusions with good surface finish. If surface finish is not important, the values can be somewhat relaxed.

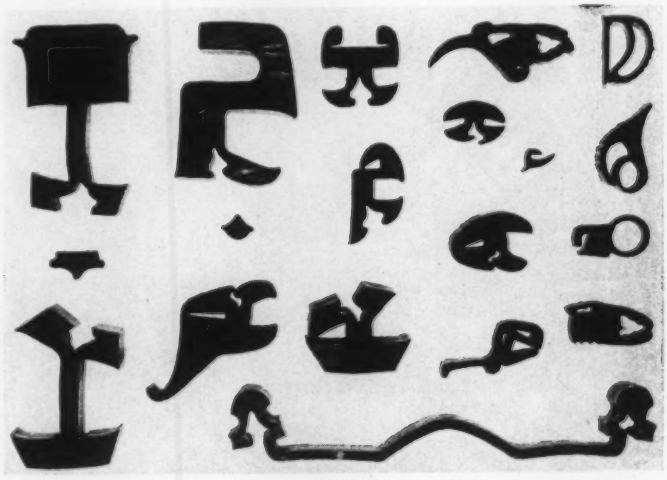


Fig. 1—Cross sections of typical rubber extrusions.

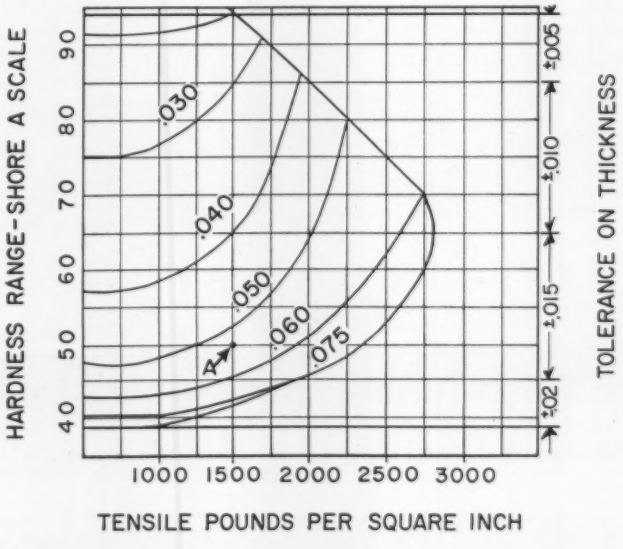
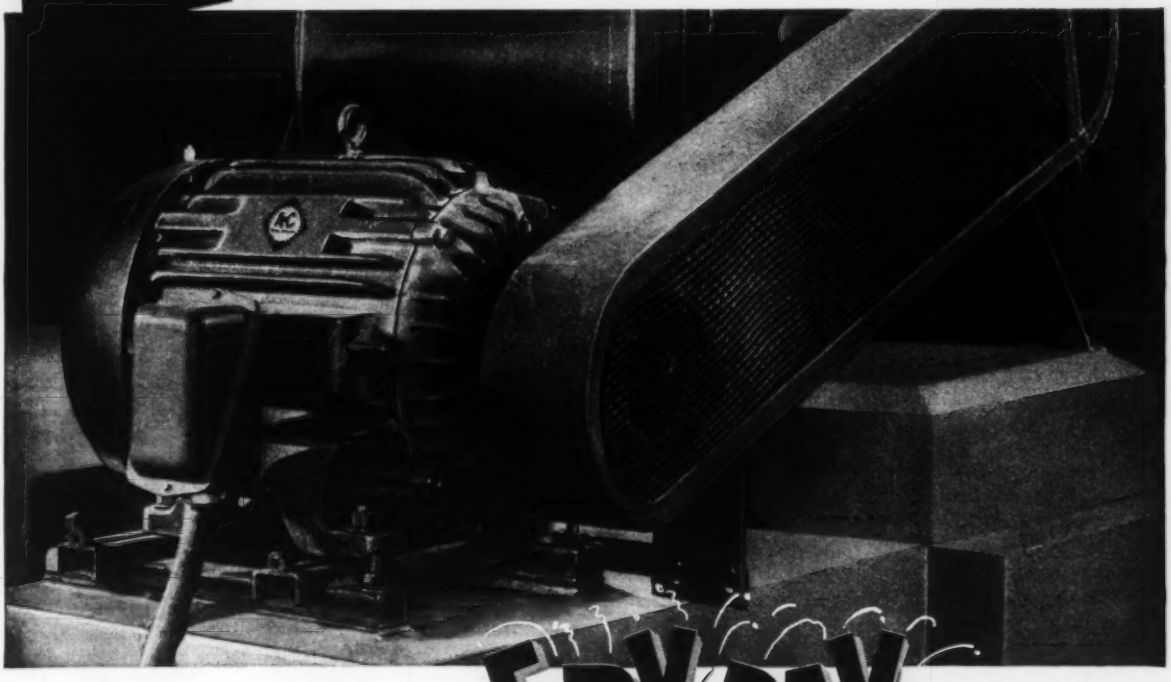


Fig. 2—Chart showing relationship of tensile strength, hardness and allowable dimensional tolerances to the practical minimum thickness of a rubber extrusion, as indicated on the curves.

For the use of extrusions made from butyl, polyacrylate, silicone, or some other specialty synthetic, the advice of a competent rubber

There's **MORE** Cooling Surface in these deep-ribbed **MOTORS**



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For More Information Circle Item Number on Yellow Card—page 19

technologist should be relied upon in preference to any generalized rules such as are included in this chart.

Extruding Dies: Extruding dies are usually high-grade steel circular plates with an aperture through which the rubber compound is forced by pressure. The extruding die may be of one-piece construction—the orifice being cut in a solid disk—or it may be made by assembling two or more sections.

Many factors must be taken into consideration when determining the size and shape of an extruding die. Allowance must be made for the amount of swell of the extruded rubber compound as it issues from the extruding machine. Also, allowance must be made for the amount of shrinkage that occurs during the curing period. The amount of swell and shrinkage varies with the rubber compound being extruded, and soft rubber compounds have a tendency to swell more than hard compounds.

The shape of the aperture in an extruding die is seldom the same as the shape of the rubber product extruded. This is due primarily to the amount of swelling which can be expected for some rubber stocks. The die shown in the left side of Fig. 3 is used to produce a nearly rectangular cross section. Examination of the aperture shows that it would have been difficult to predict the exact shape of the rubber product extruded from this die. Similarly, the rubber product shown in the right side of Fig. 3 bears only a general resemblance to the extruding die aperture from which it was produced.

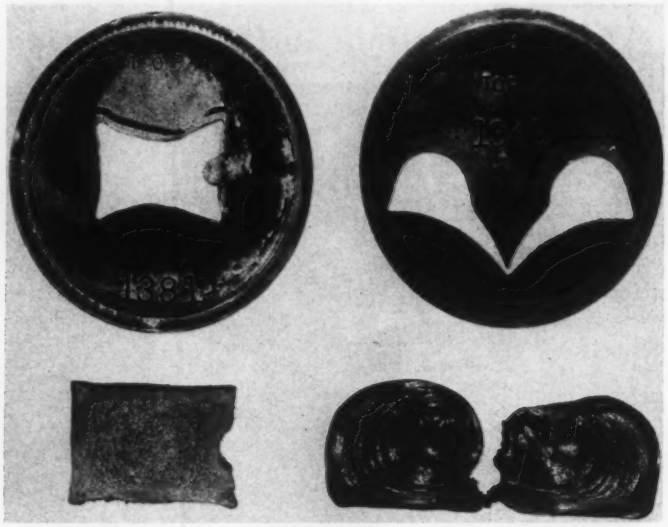


Fig. 3—Two rubber-extruding dies, top, with samples of respective rubber products, bottom.

Both of the rubber products shown in Fig. 3 were extruded from soft rubber compounds, and the amount of swelling is quite apparent. If a harder rubber compound stock had been used for extruding, the swelling would have been considerably less and, therefore, more predictable from the start. Harder rubber compounds tend to produce more uniform extrusions, and for this reason dimensional tolerances may be held to closer limits.

Extruding dies are used to produce refrigerator door sealing strips, Fig. 4. Examination of the picture reveals certain unexpected differences which exist between the die opening and the finished part. Part of the sealing strip's bulb section is completely isolated and must be supported back in the die by a mandrel.

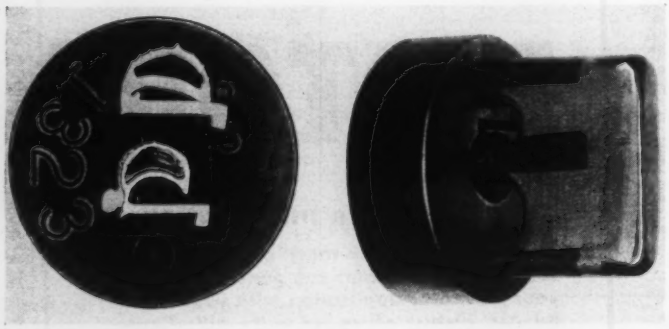


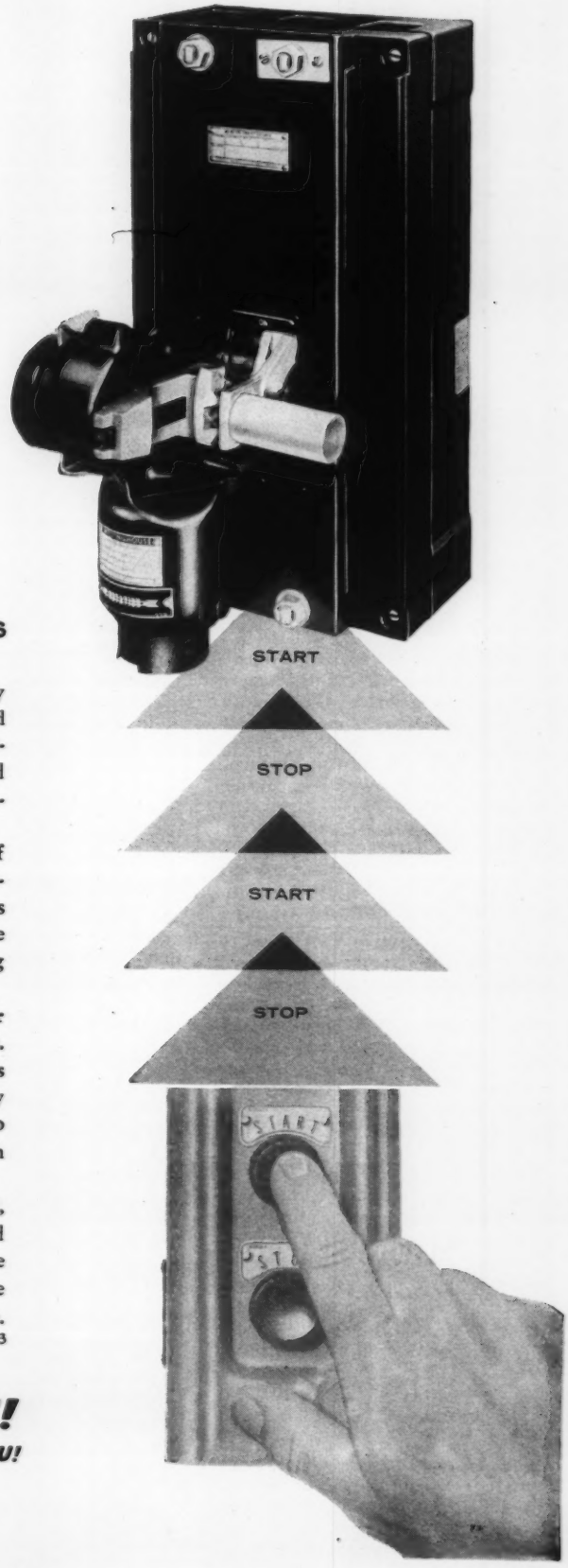
Fig. 4—Die used to extrude a refrigerator door sealing strip. The bulb section of the die is completely isolated from the rest of the die and must be rigidly supported in the back of the die by a mandrel.

From "A Discussion of Major Factors Affecting the Fabrication of Rubber Products by Extrusion" in General Motors Engineering Journal, *January-February,* 1956.

Remote or automatic switching

AT HALF THE COST

with Westinghouse motor-operated AB circuit breakers



Now you can use a pushbutton or relay to electrically operate a Westinghouse AB circuit breaker. You can add load switching to your circuit protection — from a convenient point or under pre-determined conditions. And all without the need for a costly breaker-contactor combination or an expensive, large air circuit breaker.

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With the Westinghouse motor-operated circuit breaker you get all the proved AB De-ion® protection features. In addition you have your choice of such internal aids as reverse-current trips, undervoltage trips, and auxiliary or alarm switches. The motor operator can be applied to breaker Types J, K, KL, L and M in ratings of 70 through 800 amperes.

If it's remote or automatic breaker switching you need, consider the real savings possible with motor-operated AB circuit breakers. Your local Westinghouse sales office will be glad to help — or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

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HELPFUL LITERATURE

for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Variable Speed Drives

Variable pulley, adjustable base, countershaft, adjustable pulley and variable belt drives for providing a wide range of speed variation for machines and equipment are subject of illustrated bulletin 60A. Performance data, dimensions and other design information will aid in selection and application of these versatile drives. 20 pages. Lewellen Mfg. Co.

—Circle ITEM 401

Submersible Pump Motors

Design and construction of water-lubricated submersible pump motors are illustrated in booklet "Facts about Franklin Submersible Motors." Photos show components in color, including hermetically sealed windings, the 6-shoe thrust bearing, expansion diaphragm, filter-check valve and control box. 12 pages. Franklin Electric Co.

—Circle ITEM 402

Hazardous Fluid Pumps

Engineering data in bulletin AC56 covers All-Chem rotary displacement pumps for corrosive and hazardous fluids. Pumps are offered in 3.5 and 10-gpm capacities and are available in several corrosion-resistant alloy combinations with inert nonmetallic impellers, seals and packing. 4 pages. Eco Engineering Co.

—Circle ITEM 403

Channel Wiring Duct

How Glastic channel wiring duct is utilized in Reliance V-S Drive and motor control panels to reduce manufacturing cost and maintenance is related in illustrated "Glastic Graphic News." Data on various grades of the Fiberglas-reinforced polyester laminate are given. 2 pages. Glastic Corp.

—Circle ITEM 404

Wire & Its Uses

Various kinds of wire available, information about the cold heading process and illustrations of the advantages and uses of Keystone cold heading wire are detailed in bulletin la/Ke. Design factors and typical products produced from the wire are described. 12 pages. Keystone Steel & Wire Co.

—Circle ITEM 405

Photocopying Machine

Case history on the use of a Rectigraph photocopying machine at General Mills, Inc. is subject of illustrated folder. How it speeds work and cuts costs in many diverse operations is related. 4 pages. Haloid Co.

—Circle ITEM 406

Meter-Pump

Accuracy at small flow rates is feature of the Hills-McCannameter, a meter that pumps. As described in illustrated bulletin 300, it has an encapsulated liquid end for ease of maintenance. Capacity tables and schematic drawings are included. 8 pages. Hills-McCanna Co.

—Circle ITEM 407

Bearings, Bushings & Bars

Extensive line of electric motor, general purpose, Ledaloyl and graphited bearings and universal bronze bars are listed in illustrated catalog No. 56. Motor bearings are listed by motor maker and progressive size. 110 pages. Johnson Bronze Co.

—Circle ITEM 408

Angular Position Encoders

Baldwin 13-digit and 16-digit optical type analog-to-digital angular position encoders are described in bulletin 0156. Operation and construction are detailed, as are binary and other type code disks. 4 pages. Baldwin Piano Co., Electronics Div.

—Circle ITEM 409

Castings & Plastics

"Behind the Scenes at Hampden Brass" is an illustrated booklet which describes the manufacturing facilities of this company. It turns out sand, permanent mold and die castings of nonferrous metals, besides making reinforced plastics. 24 pages. Hampden Brass & Aluminum Co.

—Circle ITEM 410

Threaded Inserts

Female threads in molded plastics, laminates, die cast alloys, powdered metal and light metals are provided by PIP push inserts. They are pushed in a drilled or cored hole without tapping. Sizes, application and other data are in bulletin 731. 4 pages. Heli-Coil Corp.

—Circle ITEM 411

Motor Controls

The 7-in. high Federal motor control units allow plug-in of up to 20 NEMA size No. 1 combination motors starters in a standard 90-in. back-to-back section. Controls are described in engineering bulletin 2-2000. 28 pages. Federal Pacific Electric Co.

—Circle ITEM 412

Polyvinyl Chloride Pipe

Normal and high impact grades of unplasticized polyvinyl chloride pipe and fittings are described in folder TD 119. Applications are listed by industry and process. Tables give physical properties, dimensions, working and burst pressures, types and weights, and thermal expansion and contraction. 6-pages. Carpenter Steel Co.

—Circle ITEM 413

1 to 30 hp Motors

Dimensions are given for NEMA rerated motors from 1 through 30 hp and frame sizes 182 through 326 in technical data sheet 242. Motors incorporate recent improvements in insulation and lamination materials to reduce size without sacrificing power output. ACEC Electric Corp.

—Circle ITEM 414

Grooved Fasteners

Descriptions of Driv-Lok grooved fasteners are contained in illustrated catalog. Line includes Driv-Lok pins and studs and Lok-Dowels. Specifications, application data and general information are given. 24 pages. Driv-Lok Pin Co.

—Circle ITEM 415

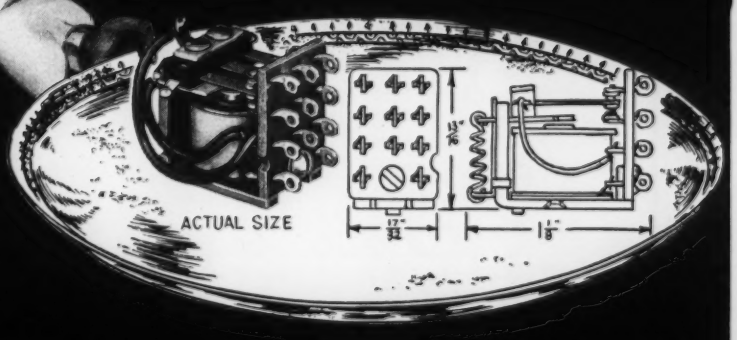
Powder Metal Parts

"What You Should Know About Solid Parts from Powder" is an il-

Potter & Brumfield, inc.

PRESENTS

Series KM RELAY



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Helpful Literature

lustrated folder that describes advantages, features, design factors and adaptability of the Supermet metal powder process. Properties are outlined. 6 pages. Globe Industries, Inc., Supermet Div.

—Circle ITEM 416

Spring Clutches

Spring clutches for effecting connect and disconnect between power sources and complementary equipment are described in illustrated data sheet. General features and applications of many types available are given. 1 page. Marquette Metal Products Co.

—Circle ITEM 417

Electronic Components

"Ideas, Techniques, Designs" is title of comprehensive bulletin which depicts application of electronic gear packaged with Alden plug-in components. Description of two "get started" kits containing all necessary plug-in components is of particular interest. 4 pages. Alden Products Co.

—Circle ITEM 418

Miniaturization Facilities

Company's facilities for sub-contract work in the field of miniaturization are outlined in brochure. The booklet sets up various applications of watch industry skills in this new field and graphically explains how these skills can be utilized by other industries. 12 pages. Elgin National Watch Co.

—Circle ITEM 419

Cementable Teflon Tape

Cementable Teflon tape as thin as 0.005-in. is now available for use as linings for conveyor guide rails, hoppers, baking pans and other surfaces handling foodstuffs and corrosive materials. Data sheet AD158 describes this lining material and an appropriate adhesive. Garlock Packing Co.

—Circle ITEM 420

Speed Reducers

Comprehensive, well - illustrated booklet No. 450 provides data on line of "Farrel Speed Reducers," recently re-engineered, rerated and expanded. Specifications, dimensions, weights and other data needed for quick selection are included. 52 pages. Farrel-Birmingham Co.

—Circle ITEM 421

Variable Speed Drives

"Vari-Speed Motodrive" is title of catalog M-558 which lists prices and performance details. These variable

Awesome press contains longest forgings ever made

Without seeing this incredible press at close range, it is difficult to grasp its true magnitude. Only a portion of the giant apparatus is shown in the photograph. Actually, it is as tall as an eleven- or twelve-story building, but the major part of it is underground. Considerably less than half of its height is visible above the working floor.

Designed and built by Loewy-Hydropress, Division of Baldwin-Lima-Hamilton Corp., this king of machines is rated at 50,000 tons. It is installed at the Wyman-Gordon-U. S. Air Force plant, North Grafton, Mass., where it is used in the making of large airplane components. It can, for example, forge an entire aluminum wing spar with a single mighty squeeze.

Speaking of forgings, the press itself actually contains some record-breakers. Its six columns consist of the eighteen longest forgings ever made. Eighteen identical steel sections, each with an overall length of 108 ft! All of these pieces were forged by Bethlehem in its Bethlehem, Pa., shops; so, too, were the crosshead supports, platen side rails, and certain other parts.

It is rare that a forge shop receives an assignment presenting such a challenge. It took months of painstaking effort to produce the column sections, but Bethlehem facilities were equal to the job. These same facilities are available to any customer who needs steel forgings. When we can be of service to you, please call or write.

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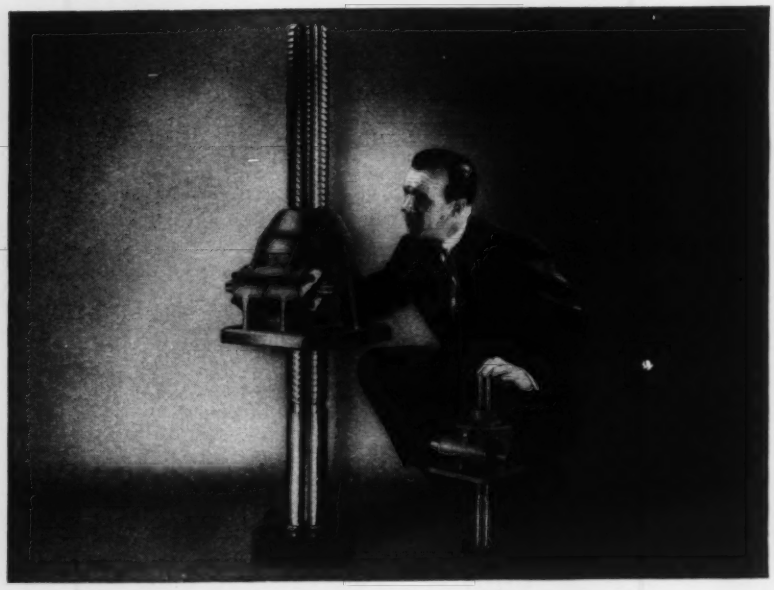
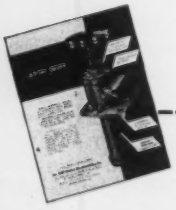


Here's A Device Every Machinery Designer Should Know About . . .

It's the Duff-Norton Worm Gear Jack, successfully used by many machine builders as a component of equipment for precise, positive control of linear motion, applying pressure, resisting impact. Two or more of these jacks can be connected by means of shafting and mitre gear boxes to give a positive drive, so that jacks always raise or lower under equal or unequal loads in perfect unison. Capacities range from 5 to 50 tons with any raise up to 25 inches; worm gear ratios, 8:1 to 96:1; turn of worm for each 1-inch raise, 10 to 180; available in either Acme or square threads. For protection against foreign matter certain models can be furnished with bellows boots.

Thousands of these jacks are in use today for table adjusting—machine adjusting—rolling mill adjusting—raising and lowering conveyors, machine beds, molds and dies, furnace lids, loading platforms, loading racks, gates, hinged mechanisms, arbor presses—adjusting electrodes—overhead crane servicing.

Duff-Norton Worm Gear Jacks are available in 6 standard sizes. For complete specifications and detailed drawings, send for your free copy of a special brochure.



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—ITEM 568—

Helpful Literature

speed drives are available in ¼ to 40-hp sizes with adjustable speed ratios as high as 10 to 1. They use NEMA frame motors and can be hydraulic, mechanical, electric, remote or automatically controlled. 44 pages. Reeves Pulley Co.

—Circle ITEM 422

Planetary Transmissions

Seven models of the Plan-Gear transmission descriptively covered in this booklet are offered with one or two forward speeds, a choice of reverse gear ratios and torque ratings of 85 or 150 to 200 lb-ft. Applications include road building, lift-truck and similar equipment. 8 pages. American Gear Mfg. Co.

—Circle ITEM 423

Central Hydraulic Systems

Revised bulletin 900 illustrates how Greer hydro-pneumatic accumulators can reduce size, complexity and operating costs of hydraulic molding equipment. Facts presented will interest design engineers or plant maintenance personnel. 8 pages. Greer Hydraulics, Inc.

—Circle ITEM 424

Socket Screws

Carbon restoration process for socket products and heat treated cap screws is described in illustrated bulletin. Surface carbon lost in steel processing is restored to create uniform hardness. Benefits of the process are detailed. 2 pages. Chicago Screw Co.

—Circle ITEM 425

Plastic Tube, Rod & Sheet

Cadco cast acrylic rods and tubes and Plexiglas acrylic sheet materials are subject of illustrated catalog. Properties, available sizes, colors and specifications are presented. Also covered are data on various other plastics offered by the company. 8 pages. Cadillac Plastic Co.

—Circle ITEM 426

Coolant Filters

Delpark self-cleaning continuous and fully automatic coolant filters for use on Micromatic Microhoning and Microflat equipment are described and illustrated in bulletin. Specifications of the optional gravity flow units are given. 4 pages. Industrial Filtration Co.

—Circle ITEM 427

Refractory Molybdenum Borides

Applications; chemical, physical and mechanical properties; and pre-

A message to the *Career-Conscious Engineer:*

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Space prevents us from listing all the reasons we believe you will find significant. There are many others. But if our brief remarks make sense to you, write us and we can explore your opportunities at Lockheed through personal interview or phone. The brief resumé below is simply for your convenience in contacting us.

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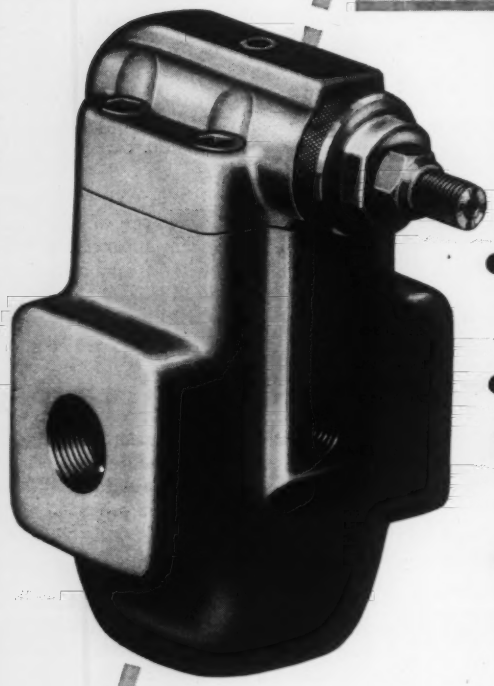

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THE HYDRAULIC PRESS MFG. CO.
Mount Gilead, Ohio, U.S.A.

HPM

NFPA NATIONAL FLUID POWER ASSOCIATION

Helpful Literature

paration of molybdenum boride compounds are described in bulletin Cdb-8 "Refractory Molybdenum Borides." Data are given on four molybdenum borides and seven multiboride systems. 6 pages. Climax Molybdenum Co.

—Circle ITEM 428

Couplings

Fixed bore, bushed type, flexible, rigid and chain couplings are described and their ratings and prices given in illustrated catalog V-169-E. Specifications for all units and horsepower rating charts are included. Latest addition to line is minimum bore chain coupling. 8 pages. Browning Mfg. Co.

—Circle ITEM 429

Fastener Finishes

Plating and surface treatment of Allen head socket screws and other products are thoroughly covered in reference booklet "Metal Finishing Standards." Sections are devoted to purposes of various finishes, advantages and limitations of plating and table of various surface treatments. 12 pages. Allen Mfg. Co.

—Circle ITEM 430

Small Lamp Sockets

Bracket-mounted sockets for small lamps described in illustrated catalog L-154 are used in electrical appliances, equipment and instruments. Groups with solder terminals and wire leads are covered. Up to 15 basic bracket types are available for particular socket types. 24 pages. Dialight Corp.

—Circle ITEM 431

One-Shot Lubricators

Up to 100 or more bearings on a machine can be served by line of One-Shot semiautomatic lubricators described in bulletin 3C. They are hand operated by push, pull or lift type levers and feed required amount of oil to each bearing. Design, engineering and application are discussed. 4 pages. Bijur Lubricating Corp.

—Circle ITEM 432

Motor Starter

Improved pressure type terminals, snap-on contact block cover for instantaneous inspection and contact servicing, a visual or audible alarm circuit, and three-color plastic coil insulation are features of bulletin 9586 ac magnetic motor starter. Full details are given in bulletin EE-191. 4 pages. Cutler-Hammer, Inc.

—Circle ITEM 433

DOW CORNING CORPORATION

Silicone News

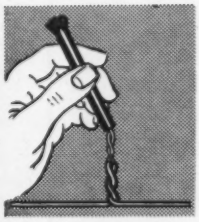
FOR DESIGN ENGINEERS No. 28

Waterproof Wire Splice With Silicone Compound

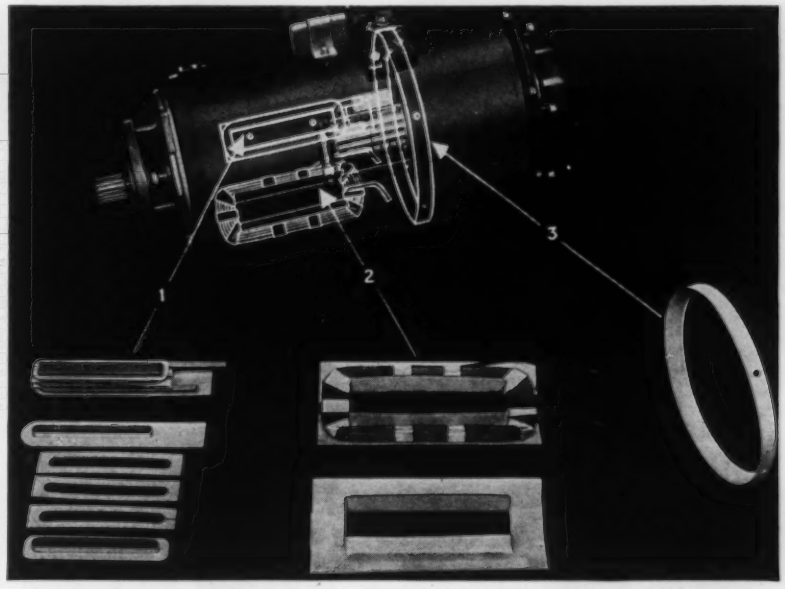
The sales success of "Super-Splice", designed by Superior Cable Corporation, Hickory, N. C., testifies to the superior dielectric properties of Dow Corning Silicone Compound. Over 2,000,000 of the splices have been sold in the last two years.

Originally developed for telephone cable work, the "Super-Splice" is a simple polyethylene sleeve sealed at one end and filled with grease-like Dow Corning silicone compound. It is quickly and easily slipped over twisted pigtails to form a splice that retains optimum electrical insulating properties despite prolonged exposure to moisture.

Extensive laboratory tests have proved that "Super-Splice" retains its full insulating effectiveness even after a full year under water. During these tests, splices featuring polyethylene-insulated wire protected with silicone-filled "Super-Splice" withstood 45,000 volts dc and measured 200,000 megohms insulation resistance while immersed in water.



Since the silicone compound does not harden with aging, the insulator may be removed at any time to facilitate maintenance. "Super-Splices" now available are 2⅛" long and are suitable for straight, butt or bridge splices of 19, 22 or 24 gauge wire. *No. 279*



Silicone-glass components: 1. interpole insulator; 2. shunt field coil insulator; 3. insulator ring.

Bendix Reduces Size And Weight Of Turbojet Generators With Silicone-Glass Laminates

By utilizing the superior thermal stability and dielectric strength of silicone-glass laminates, Red Bank Division of Bendix Aviation Corporation has designed new compactness and efficiency into a generator that meets the rugged requirements of turbojet operation.

This Type 30E10-1 Generator, a 30-volt 400 amp unit, is 6½ inches in diameter and weighs only 67 pounds. Developed to operate at speeds as high as 8000 rpm and for air-blast cooling at altitudes up to 65,000 feet, it features light weight insulating components formed of 2-ply silicone-glass cloth fabricated by Stevens Products, East Orange, N. J. *(cont'd pg. 2)*

New Silicone Based Paint Signals Danger Temperature

Through ingenious use of heat stable Dow Corning silicone resins, Tempil Corporation, New York City, has developed a paint that provides a visual alarm when surfaces are getting too hot for safety. The new paint, "Temp-Alarm ° GA-1", changes color from yellow to maroon at temperatures from 375 to 400 F.

Currently, this new silicone based coating is used on the exteriors of mixing tanks in steel mills. By changing color at the danger temperature, it warns when the tank's fire brick lining is wearing thin.

Since temperatures involved are relatively low so far as the silicone vehicle is concerned, Tempil has been able to concentrate on the proper pigments for desired color sensitivity without fear of paint failure. Even after prolonged exposure to temperatures just below the "danger" range, the paint retains its original dependability. *No. 280*

CLASS H MOTOR STILL ON TEST AFTER 57,417 HOURS AT 240 C

At 10 A.M., June 6, 1946, a Class H insulated 5 hp motor was generator loaded to operate at its test temperature of 240 C in Dow Corning's motor test labs. Every 500 hours since it has been shut down and exposed to 100% relative humidity for 24 hours. As of 11 A. M. June 1, 1956, this motor was still on test after 57,417 hours at an average copper temperature of 240 C! That's equivalent to 349 years operation at the Class H temperature of 180 C.

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

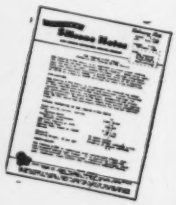
MORE

XUM

DOW CORNING CORPORATION

Silicone News

DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . . .



"What's a Silicone?" is the title of a 32-page booklet which answers that often asked question in semi-technical terms. Indexed and illustrated, this booklet has earned an international reputation as the most interesting and informative description of silicones ever published. *No. 284*

Lightweight electrical and electronic parts with excellent heat and moisture resistance, high mechanical strength and good dielectric properties can be produced with Dow Corning 301 Molding Compound. Heat distortion temperature of molded parts is greater than 900 F; flexural strength is 12,000 psi. *No. 285*

Silastic, the Dow Corning silicone rubber, keeps its shape, stays resilient from —100 to 500 F; resists hot oils and chemicals; withstands weathering ozone and corona; and is an ideal dielectric material. Properties of Silastic are fully detailed in new reference brochure. *No. 286*

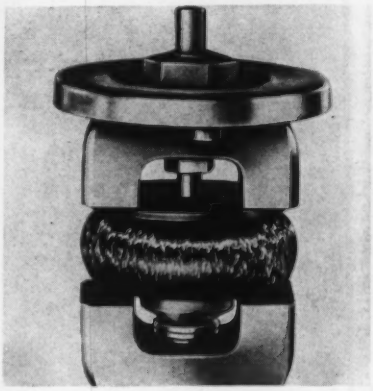
Illustrated brochure presents factual evidence that Dow Corning 41 Silicone Grease cuts relubrication schedules and replacement costs in a wide variety of high temperature, low speed applications. Includes several illustrated and documented case histories describing effectiveness of 41 Grease in oven conveyor bearings, dolly wheels, injection valves and turbine governors. *No. 287*

New booklet on Silicone Based Paints describes and illustrates how these heat, moisture, weather and oxidation resistant coatings improve product finishing and reduce maintenance costs on equipment ranging from industrial furnaces and exhaust stacks to domestic space heaters and garbage incinerators. Also explains difference between the straight silicone and modified silicone paints now available from more than 50 formulators listed as sources of supply. *No. 288*

Now available—1956 Reference Guide to Dow Corning Silicone Products. A concise, comprehensive, 12-page reference that is convenient-to-use. It's packed with data, properties, and information on how you can use silicones in designing new equipment, improving performance and reliability of original equipment, or reducing production and maintenance costs. *No. 289*

Seal And Spring In Toridal Inductor Made From Silastic

Superior resistance to compression set, even after prolonged exposure to high or low temperatures, has made Silastic*, Dow Corning's silicone rubber, increasingly popular among designers once hampered by the temperature limitations of organic rubber. Here, for example, is how Burnell & Co., Inc., uses Silastic to make a new variable toridal inductor more efficient and dependable at temperatures ranging from —100 to over 500 F.



The "Rotoroid" inductor comprises a toroid coil and two permanent magnets. One of the magnets is rotatable to produce a continuously adjustable biasing field for electronic circuitry. To provide a positive seal where the controlling shaft enters the unit's hermetically sealed housing, the shaft is fitted with a "Hexseal" locknut that has a heavy Silastic cover, molded by APM Co. To permit the shaft to turn freely, and yet maintain a tight seal, a very small amount of Dow Corning 200 Fluid, 1,000,000 centistokes, is applied to the well of the locknut.

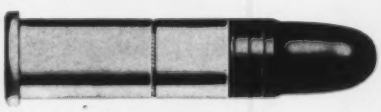
Silastic also serves as a thrust and centering spring inside the "Rotoroid." Here a high durometer Silastic is used. In service this silicone rubber spring has proved to have excellent service life, retaining its original resiliency over a much wider temperature span than any metal spring.

In many electronic applications, such as guided missile telemetering systems, the thermal stability made possible through the use of Silastic parts, is vital to the "Rotoroid's" accurate performance. *No. 282*

*T.M. REG. U.S. PAT. OFF.

Silicone Lubricated Cartridge Improves .22 Rifle Performance

For the ultimate in accuracy and reliability leading designers of clocks and instruments years ago standardized on Dow Corning silicone lubricants. With a different kind of accuracy in mind, but one that requires the same calibre of precision performance, Remington Arms designers have specified a silicone lubricant for their new "Match 22" long rifle cartridge.



Custom-designed for target rifles, particularly the new 40X "Rangemaster" rifle, this cartridge features a new wind-bucking design, close-tolerance brass case, and an improved rim shape for better ignition. As the finishing touch, each "Match 22" is coated with a special lubricant based on Dow Corning 550R Fluid. This silicone lubricant keeps the cartridge clean and dry to the touch; does not foul the barrel; eliminates the need for cleaning the barrel between firing targets. Users report the silicone lubricant seems to add more accuracy to the bullet's flight. *No. 283*

SILICONE-GLASS LAMINATES *(continued)*

The extremely thin-walled construction of these parts provides more space for circulation of cooling air than possible with the several layers of tape conventionally used. In addition, the silicone-glass laminates are lighter in weight than the tape insulation. Quickly "snapped" into place, they effect substantial savings in assembly time and costs. *No. 281*

Dow Corning Corporation, Dept. 6807, Midland, Michigan

Please send me: 279 280 281 282 283 284 285 286 287 288 289

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY ____ _____ ZONE____ STATE_____

SILICONE NEWS is published for product design and development engineers by

DOW CORNING CORPORATION

first in silicones

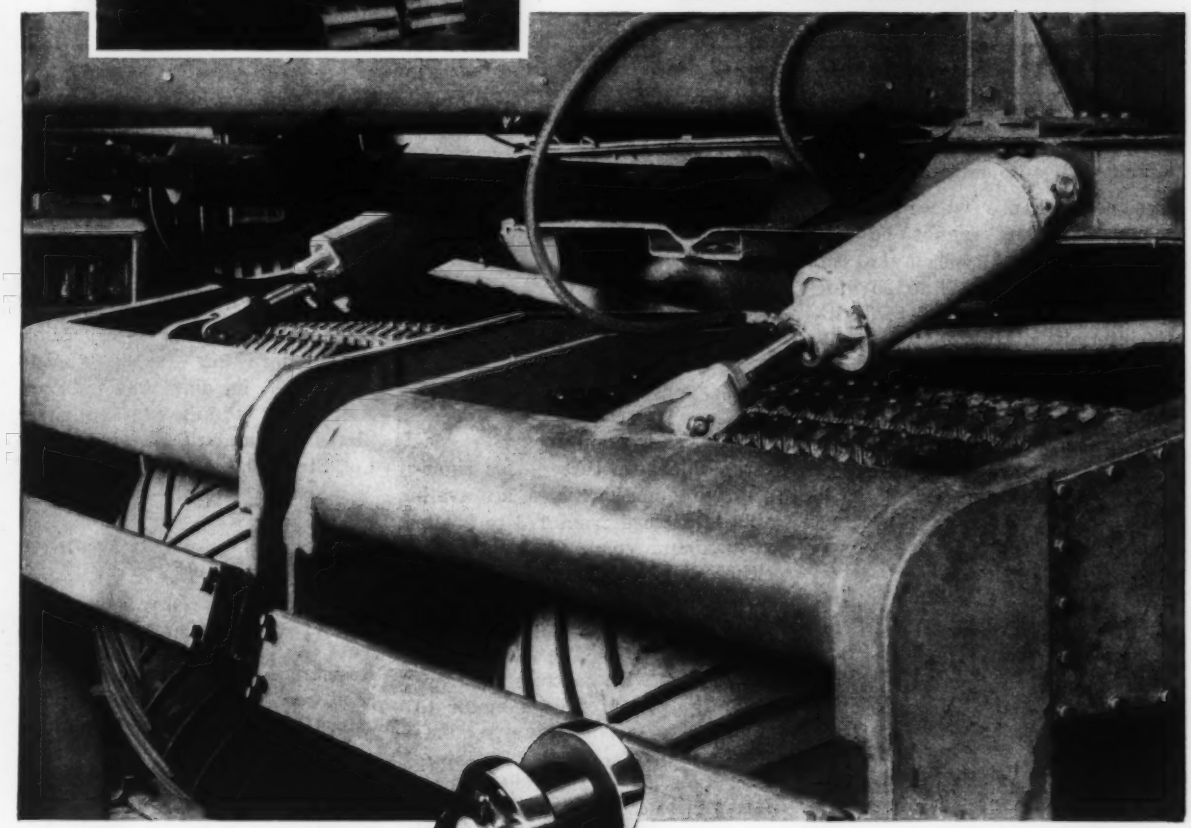
DOW CORNING SILICONES

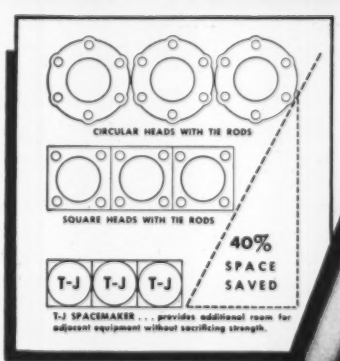
MIDLAND MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

Arctic Cargo Carrier Depends On T-J Spacemaker CYLINDERS




CIRCULAR HEADS WITH TIE RODS
SQUARE HEADS WITH TIE RODS
40% SPACE SAVED
T-J
T-J
T-J
T-J SPACEMAKER . . . provides additional room for adjacent equipment without sacrificing strength.

Saves 40% Space!
No Tie Rods For Greater Strength

Differential axle loading through T-J Spacemaker Air Cylinders forms a controlled walking beam in this Teracruiser, designed and produced for the Army Ordnance Corps by the Four Wheel Drive Co., Clintonville, Wis.

Weight of cylinders was important factor in choosing T-J Spacemakers, which reduce weight while providing same displacement and extra high safety factor. Fast delivery and space-saving features also favored T-J. Exclusive with T-J are new Super Cushion Flexible Seals for Air (to 200 P.S.I.) . . . and New Self-Aligning Master Cushion for Oil (to 750 P.S.I.). Hard chrome plated bodies and piston rods are standard, at no extra cost. Wide range of styles, capacities . . . 64,000 combinations *off the shelf!* Write for bulletin SM-155-3. The Tomkins-Johnson Co., Jackson, Mich.

ALL MODELS . . . OFF SHELF DELIVERY

MEETS WITH ALL JIC RECOMMENDATIONS

T-J TOMKINS-JOHNSON
RIVITORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

—ITEM 572—

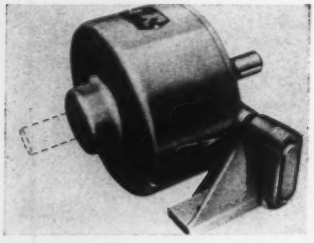
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Magnetic Brake

is separately mounted disk unit with automatic reset

Designed for use where end-bell mounted brakes cannot be employed, this disk-type brake has torque ratings from 3 to 25 lb-ft (continuous duty) and 3 to 35 lb-ft(intermittent duty). It is available with self-contained bearings and shaft for application where a coupling is used between machine and brake. Second model, without integral shaft, permits extension of the machine drive shaft directly into the brake. Lining wear adjustment is automatic; set and release action is fast and direct without levers or linkage. Release is manual, reset is automatic. **Reuland Electric Co.**, 3001 W. Mission Rd., Alhambra, Calif.

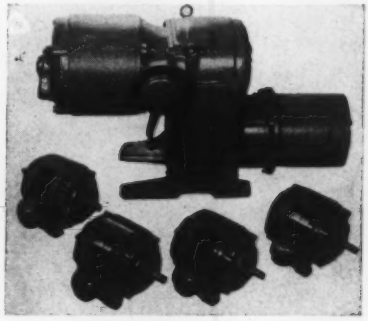


—Circle ITEM 451

Multiple-Drive System

provides co-ordinated motor speed changes

For applications requiring co-ordinated speed changes in several variable-speed motors, this synchronized, variable-speed multiple-drive system interlocks Varidyne motors by means of electrical impulses. Turning the control dial on the power unit varies the speed of every motor in the system equally and simultaneously. Motors, which are three-phase squirrel-cage induction types, are available in ratings from 1/3 to 25 hp at maximum rpm. Enclosures are either drip-proof, totally enclosed or explosion-proof. Speeds from 1 to 10,000 rpm are provided in ratios up to 5:1. The systems can be supplied with controls for trimming the speed of each motor to compensate for individual requirements. **U. S. Electrical Motors Inc.**, Box 2058, Terminal Annex, Los Angeles 54, Calif.

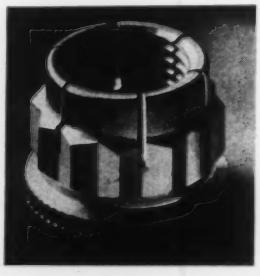


—Circle ITEM 452

Locknuts

withstand temperatures to 1200 F

One-piece, all-metal self-locking nuts—with 12-point external wrenching design — are intended for use where temperatures reach 1200 F, such as in jet engine manifolds, afterburners and similar applications. Designated 119FW, the nut has a slotted locking collar which is squeezed slightly during manufacture. As the nut is threaded on the bolt, the collar segments expand. Spring tension of the segments holds the nut securely in place under severe vibration. Made in standard sizes from No. 10 through ½ in. diam, the nuts are AMS 5735 stainless steel, silver plated. **Standard Pressed Steel Co.**, Steward Ave., Jenkintown, Pa.

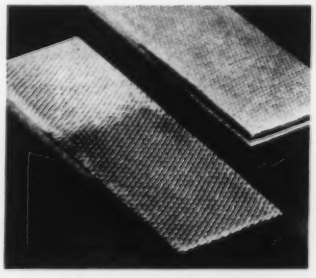


—Circle ITEM 453

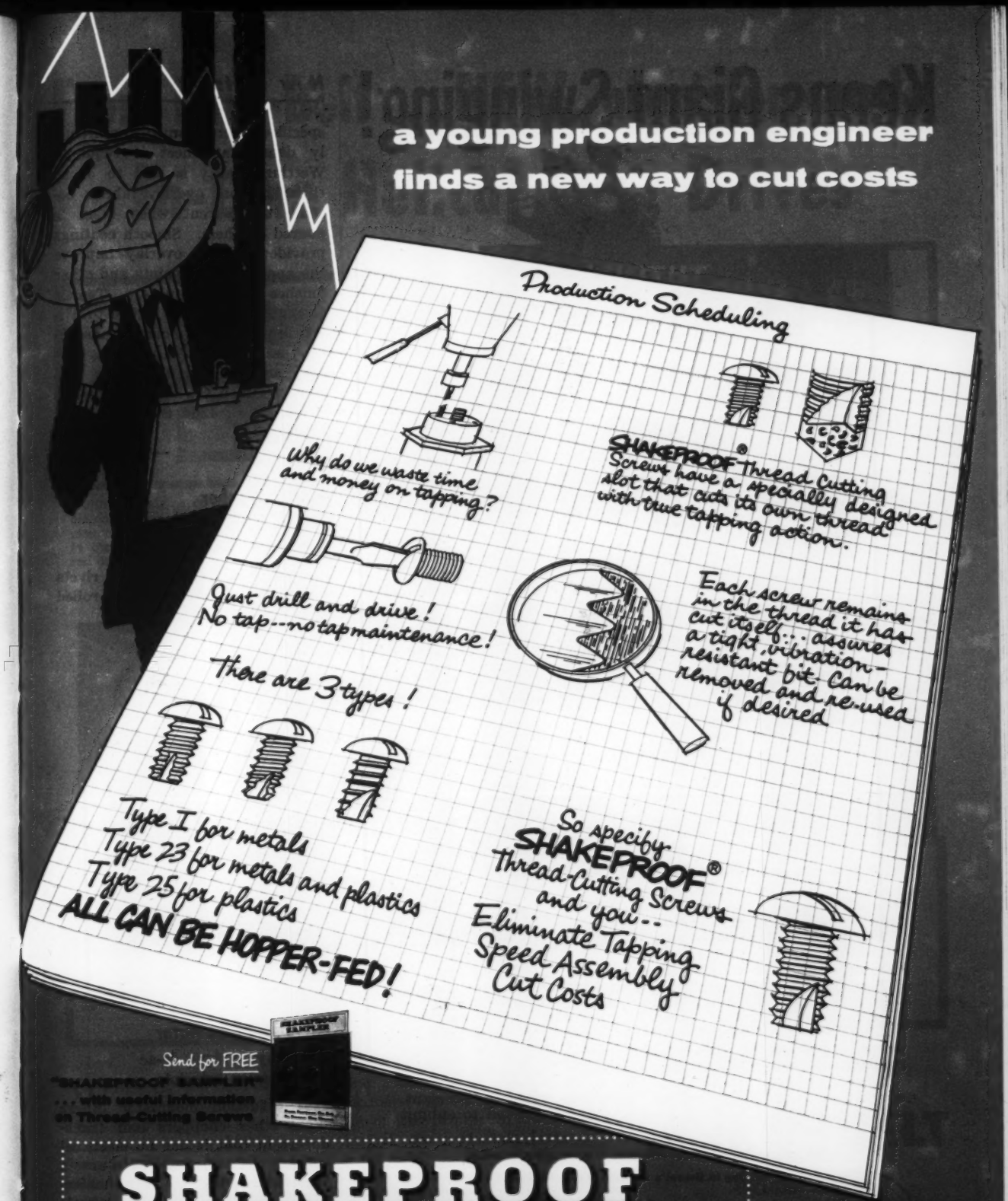
Dynel Overlays

protect low-pressure laminates from chemicals and abrasion

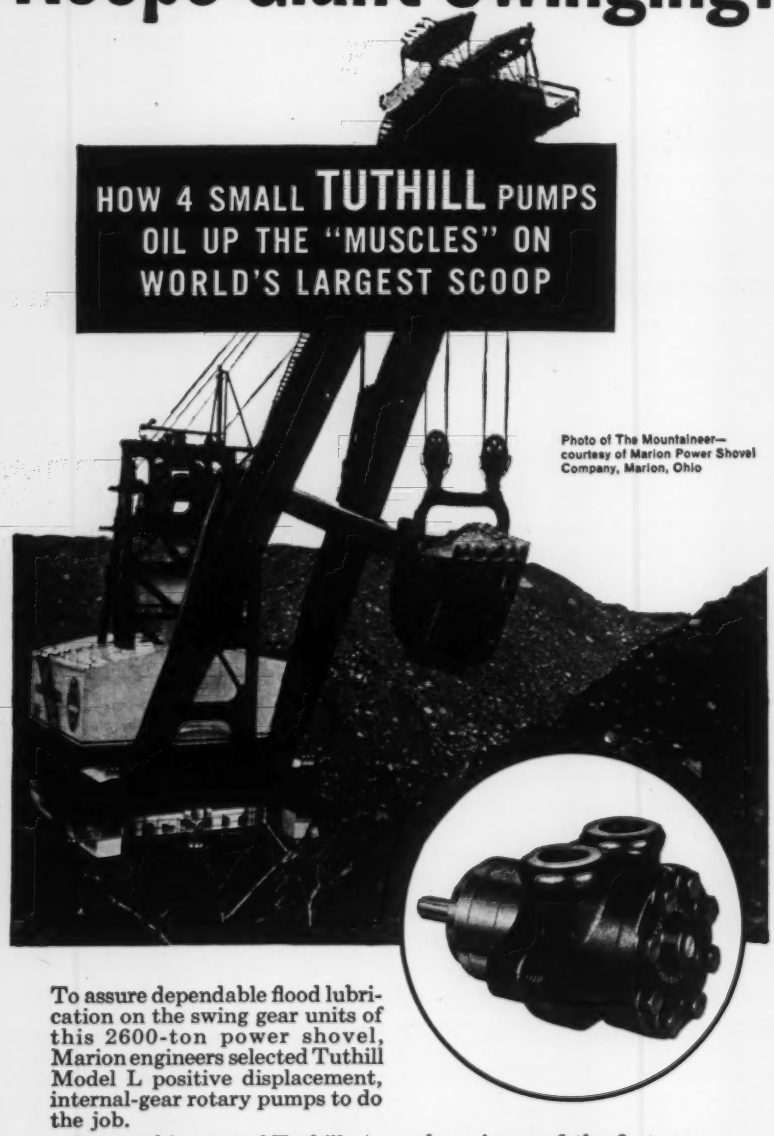
Resistance of low-pressure glass-reinforced laminates, such as polyesters, phenolic or epoxy-resin laminates, to chemicals and abrasion is markedly improved by this Dynel fabric overlay. Typical applications include glass-reinforced laminated boat hulls, aircraft assemblies, automobile bodies, structural panels, and other products exposed to weather damage, abrasion, salt water or chemicals. For use on articles subjected to excessive pulling and tugging, woven Dynel fabrics are recommended; non-woven fabrics are usually



Facing Page—ITEM 573→


a young production engineer
finds a new way to cut costs
Production Scheduling
Why do we waste time and money on tapping?
SHAKEPROOF® Thread Cutting Screws have a specially designed slot that cuts its own thread with true tapping action.
Just drill and drive! No tap--no tap maintenance!
Each screw remains in the thread it has cut itself... assures a tight, vibration-resistant fit. Can be removed and re-used if desired
There are 3 types!
Type I for metals
Type 23 for metals and plastics
Type 25 for plastics
ALL CAN BE HOPPER-FED!
So specify SHAKEPROOF® Thread-Cutting Screws and you--
Eliminate Tapping
Speed Assembly
Cut Costs
Send for FREE
"SHAKEPROOF SAMPLER"
... with useful information on Thread-Cutting Screws
SHAKEPROOF
"Fastening Headquarters"®
St. Charles Road, Elgin, Illinois • Offices in Principal Cities
In Canada: Canada Illinois Tools Limited, Toronto, Ontario
SHAKEPROOF
FASTEX
DIVISIONS OF ILLINOIS TOOL WORKS
World's Broadest Line of Mass-Assembly Fastenings

Keeps Giant Swinging!



HOW 4 SMALL **TUTHILL** PUMPS OIL UP THE "MUSCLES" ON WORLD'S LARGEST SCOOP

Photo of The Mountaineer—courtesy of Marion Power Shovel Company, Marion, Ohio

To assure dependable flood lubrication on the swing gear units of this 2600-ton power shovel, Marion engineers selected Tuthill Model L positive displacement, internal-gear rotary pumps to do the job.

It was this type of Tuthill pump that pioneered the first practical mechanical seal for leak-free performance and low power consumption. Since 1927, hundreds of thousands of these compact small pumps have demonstrated their dependability to hold prime, deliver capacity needed, and operate quietly and uninterruptedly.

Whether your production calls for standard pumping units or special pumps for engineered applications in lubrication, coolant, hydraulic or liquid transfer service, you are invited to submit your specifications for recommendation.

Write for catalog data for lubrication or other specific needs.

See our catalog in Sweet's Product Design File 6b-Tu

TUTHILL PUMP COMPANY

Dependable Rotary Pumps . . . since 1927

939 East 95th Street, Chicago 19, Illinois

Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd. Ingersoll, Ontario, Canada

—ITEM 574—

For More Information Circle Item Number on Yellow Card—page 19

New Parts

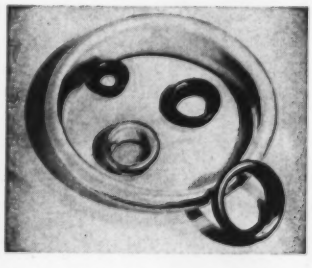
specified where a smooth, extremely dense flat sheet is required. Wetting quality is said to be so thorough that overlay fabrics become transparent when resin is poured on them. Smooth coatings provided by the overlay improve the application of paints and other finishes on laminate. Tensile strength of Dynel is 40,000 to 57,000 lb per sq in.; moisture absorbency is less than 0.4 per cent. **Carbide and Carbon Chemicals Co.,** Div. of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y.

—Circle ITEM 454

Plastic Washer

seals, locks and insulates fasteners

For use with bolts, screws, rivets or nails, these Zytel nylon rolled



washers cold-flow around the fastener when it is tightened. The washer fills all spaces between the fastener body and hole, providing an air-tight, leak-proof seal. It also acts as a locking device, prevents galling and dampens vibration. **Nyltite Corp. of America,** Union, N. J.

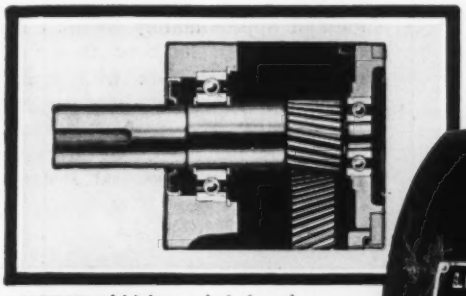
—Circle ITEM 455

Induction Modulator

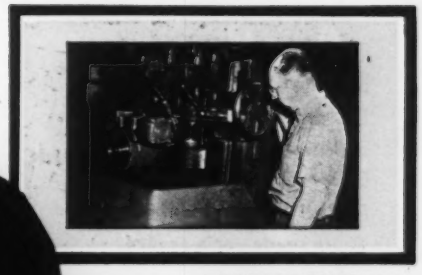
employs unique dc-ac conversion principle

This induction modulator differs from other choppers and transducers in that it has no electrical contacts. Component parts are: a Weston moving coil mechanism that is positioned by a dc signal; ac field coils which induce an alternating voltage in the moving coil proportional to its position. The modulator presents a constant resistance to the dc signal input, and output wave form is

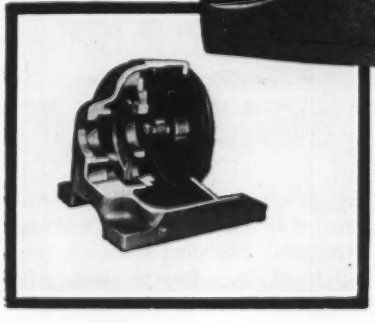
From Link-Belt . . . NEW, precision-made In-Line Helical Gear Drives



RIGIDITY of high speed shaft and pinion is provided by straddle-mounting—of extreme importance in coping with shock, reversing and heavy loads.

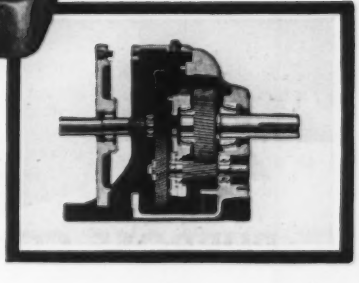


HARDENED GEARS are produced on modern hobbers and are accurately shaved. This provides the ultimate in gear performance.



OIL-TIGHT DESIGN is provided by one-piece, close-grained cast iron housing with effective oil seals.

ONE LOW-SPEED GEAR SET per drive size and maximum accessibility of all operating parts simplifies maintenance.



WHEREVER you need dependable speed reduction up to 118 hp . . . and strength and long life are major factors — new Link-Belt In-Line Helical Gear Drives are specifically equipped for the job. In their smooth, corrosion-resistant, husky cast iron housing . . . hardened, precision, double or triple reduction gear sets accurately provide required speed.

Space requirements and layout problems are minimized by locating input and output shafts in the same horizontal and vertical planes. Design of drive permits the addition of integral, positive-locking backstop at any time.

Get the full story on these advanced new drives, ratios 6.2:1 to 292:1, in 16-page Book 2651. It's available from your nearby Link-Belt office or authorized stock-carrying distributor.

LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,898

—ITEM 575—

ILSCO

THE BIG LUG OF INDUSTRY

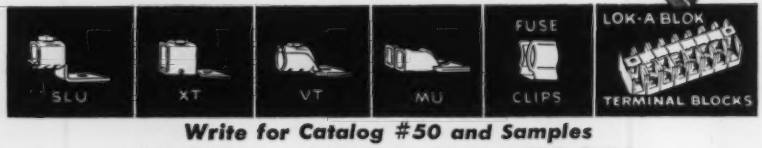
For Superior Quality
√ Check these features

- ☐ Pure copper, 100% conductivity
- ☐ Wide wire range—re-usable
- ☐ U/L-CSA Approved
- ☐ Compact—rugged
- ☐ Advanced designing
- ☐ Sound engineering
- ☐ Speedy installation
- ☐ Cool operation—takes overload
- ☐ No special tools needed
- ☐ All screws wax-treated for better clamping

MODEL LO

ALL THESE FEATURES AT LOW COST

Your √ Test Will Prove ILSCO Superiority Over Cast Or Any Other Type Lugs



Write for Catalog #50 and Samples

ILSCO CORPORATION

5752 MARIEMONT AVE. CINCINNATI 27, OHIO

—ITEM 576—

RAWSON

4 PURPOSE COUPLING

Rawson Couplings will enable your motors to start heavy loads in seconds, keeping down your electric power demand charge. Made up to 1000 h.p. Simple in action; effective in service. Rawson is a 4-purpose coupling—transmitting smoothly loads between motor and machine—hundreds of applications—*Starts . . . couples . . . cushions . . . limits load.*

RAWSON COUPLING DIVISION

O. S. Walker Co., Inc. **Worcester, Massachusetts**

—ITEM 577—

New Parts

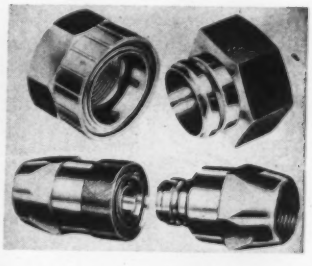
sinusoidal. It has a conversion gain of approximately 28 db, and capacitors can be used to make output in quadrature with input if desired. Compact, light-weight hermetically sealed construction makes the unit moisture and dust-proof. **Weston Electrical Instrument Corp.**, 614 Frelinghuysen Ave., Newark 5, N. J.

—Circle ITEM 456

Quick Coupling

holds fast against pressure, twisting or shock

One-quarter turn locks this quick coupling with a leakproof seal that is not affected by vibration, pressure or rotation of the hose. It is available in both open and self-sealing types; stock couplings are steel and other materials are available on special order. Ball-locking groove on the nipple is heat treated to ensure long life and high strength. Coupling sizes are from ¼ to 3 in. **Roylyn Inc.**, 1706 Standard Ave., Glendale 1, Calif.



—Circle ITEM 457

Single-Bearing Motor

is rated at 1½ through 16 w

AM-4 lightweight MonoMotor, developed specifically for the refrigeration and air conditioning industries, is also adaptable for many other applications. Patented lamination design, which adds to the magnetic flux area, increases motor efficiency and raises starting

JACK COLE *cuts trip time 20%*

. . . with FULLER Semi-automatic ROADRANGER® Transmissions

It's now 24 hours instead of 30 from Birmingham to New York and 26 instead of 32 hours from Birmingham to Philadelphia. Jack Cole Company's new fleet of 43 GMC 860 diesel tractors equipped with Fuller 10-speed semi-automatic R-96 ROADRANGER Transmissions have cut 6 hours off each trip.

Says Jack Cole, President of Jack Cole Company, Birmingham, Alabama: "Our Fleet Supervisor, O. B. Johns, Jr., insisted on the ROADRANGER Transmission for the new tractor to get the ability needed for faster trip time."

Fuller ROADRANGERS provide extra *ability* with:

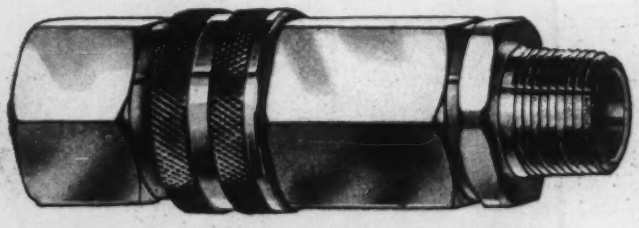
- **Easier, quicker shifts—10 forward speeds with short 28% steps between ratios**
- **One shift lever that controls all 10 forward speeds**
- **No gear splitting — 10 selective gear ratios evenly and progressively spaced**
- **Higher average road speeds — engines operate in peak hp range with greater fuel economy**
- **Less driver fatigue—⅓ less shifting**
- **Range shifts pre-selected — automatic and synchronized**
- **Space-and-weight-saving economies — the most compact 10-speed transmission available**
- **Transmission weight under the cab—permitting more cargo to be carried on the payload axles**

To shorten trip time—to cut maintenance costs—to give *your* drivers complete control of every driving condition, specify Fuller semi-automatic ROADRANGER Transmissions.

FULLER MANUFACTURING COMPANY
TRANSMISSION DIVISION • KALAMAZOO, MICH.

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

—ITEM 578—



From raw materials to finished products—

Titeflex Quick-Seal Couplings

"make connections"... fast!

Quick-Seal couplings are absolutely leakproof. Couple and uncouple in just one second . . . *without* tools. And Quick-Seal couplings keep the lifelines of your operation open and flexible—allow *free* flow of liquids, gases, lubricants in any direction. Suitable for *all* industrial applications.

Check the drawings (above) for typical applications. Use it as a guide to uncover new profitable uses for Quick-Seal couplings in your plant.

1 High pressure testing
2 Diesel engine refueling lines
3 Furnace cooling water lines
4 Tank car unloading
5 Mass production testing
6 Rolling mill hydraulic lines

Titeflex

TITEFLEX, INC. Industrial Products Division
508 Hendee Street, Springfield 4, Mass.
Please mail your free Quick-Seal Coupling Catalog . . . without obligating us.

Name_____ Title_____

Firm_____

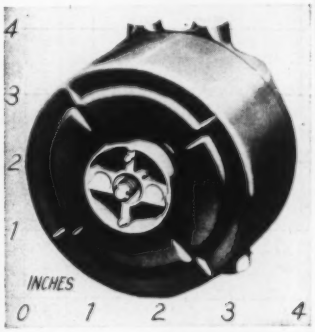
Address_____

City_____ Zone_____ State_____

Titeflex Quick-Seal Couplings • *leakproof at all operating pressures, in every application*

—ITEM 579—

and running torques. Stator core frame is precision diecast in one piece, enabling extremely close tolerances to be maintained in manufacture. Design also incor-



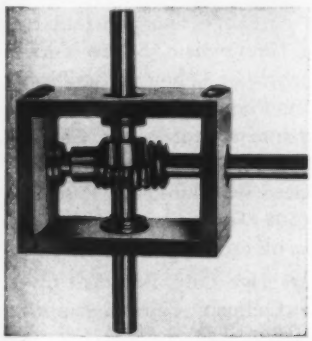
porates all-angle operation and interchangeability to accommodate all standard brackets and special mounts. Rated at 1½ through 16 w, the motor is of four-pole design, 1550 rpm, 115 v, 60 cycle; it is also available in other voltages and frequencies. **Redmond Co. Inc.**, Owosso, Mich.

—Circle ITEM 458

Gear Reducers

have bevel or worm gears

Right-angle drives for control shafts are available with dual output shafts in two basic types. They have a variety of input-output ratios, and either bevel or worm gear assemblies. Both types have an-



odized aluminum dustproof housings, measuring 1 x 1½ x 1½ in., with gears permanently pinned to stainless steel shafts mounted in bronze bearings with constant pressure thrust washers. The BG series employs precision bevel gears and is available with input-

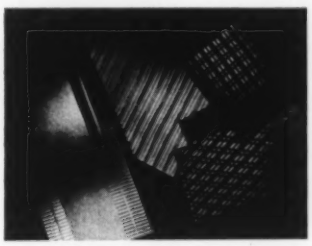
output ratios of 1:1, 2:1 and 3:1. The WG series with worm gear assembly is especially suited to handle spring or gravity-loaded controls, since the output shaft automatically locks in position and the input shaft remains free for smooth drive in either direction. This series is available with ratios of 5:1, 10:1 and 20:1. **Jan Hardware Mfg. Co. Inc.**, 75 N. 11th St., Brooklyn 11, N. Y.

—Circle ITEM 459

Prefinished Metals

in stripe, pattern or crimp decoration

Prefinished metals, in sheets, strips or coils, can be used for complete product fabrication of small units and for trim or paneling on larger appliances such as ranges and refrigerators. The machined finish can be supplied in a wide variety of patterns, stripes of all types,



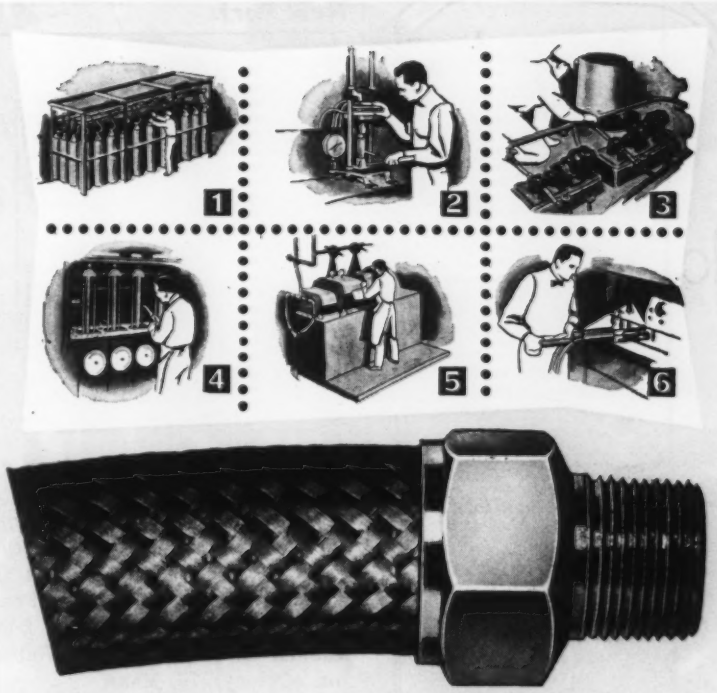
combinations and widths. Material affords substantial production economies over individual piece plating or finishing methods. **Apollo Metal Works**, 6650 S. Oak Park Ave., Chicago 38, Ill.

—Circle ITEM 460

Fastener

can be used as a rivet or nut

Perma-Nut combines the permanence of a rivet with the disassembly features of a nut. It is basically a tubular rivet with a hole in the head tapped with standard threads. Radial serrations on the underside of the head bite into the workpiece, preventing it from turning once it has been clinched. The fastener can be set automatically at production rates on conventional riveting machines. It allows permanent installation of a



Here, there, everywhere in the plant... you find money-saving uses for

Titeflex flexible metal hose

Here's the hose that licks critical corrosion, temperature, vibration and pressure problems in conveying gases, liquids, lubricants. *Universal* applications. All-metal construction. Braided or unbraided. Alloys to meet *every* need.

Investigate. Check the drawings (above) for ideas in the use of Titeflex Flexible Metal Hose in your plant. Use coupon to obtain information about this versatile and durable all-metal hose.

1 Fire extinguisher systems
2 Plastic presses
3 Food processing equipment
4 Electronic degassing equipment
5 Machine tools
6 High frequency conductors

Titeflex

TITEFLEX, INC. Industrial Products Division
508 Hendee Street, Springfield 4, Mass.

Please send your free Titeflex Flexible Hose Catalog without obligating us.

Name_____ Title_____

Firm_____

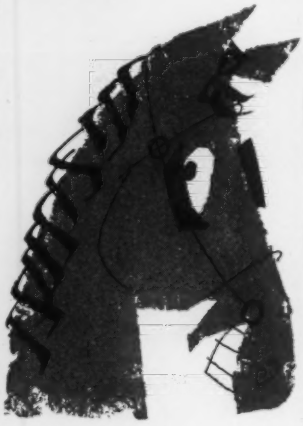
Address_____

City_____ Zone_____ State_____

TITEFLEX FLEXIBLE METAL HOSE licks corrosion, temperature, vibration, pressures in all industrial operations

—ITEM 580—

It's good Horse Sense to choose SPEER Carbon Brushes



You hold a pay-off ticket when you specify Speer application-tested brushes for any fractional horsepower installation. Every Speer brush is a performance-proved winner, tested in the laboratory and on the job to give you . . .

- EVEN WEAR
- IMPROVED COMMUTATION
- REDUCED VIBRATION
- LONGER BRUSH LIFE

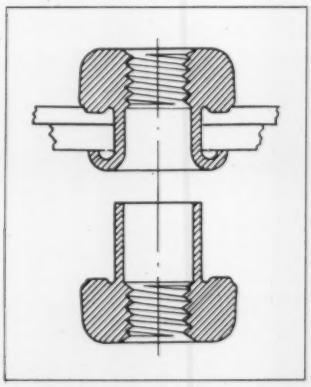
Through 50 years of carbon and brush specialization, Speer has developed a broad variety of carbon and graphite brushes to meet the requirements of every type installation. *Write today for "Brushes by Speer"* containing valuable data on the characteristics and applications of Speer's complete line of brushes.

SPEER Carbon Co.
St. Marys, Pa.

Send catalog: "Brushes By Speer"
Name
Title
Address
City State

—ITEM 581—

New Parts



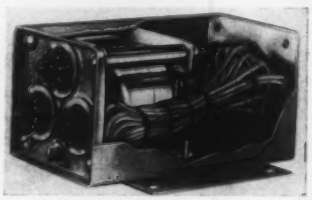
nut in an area which is hard to reach or blind after final assembly. Produced by cold heading, the fastener is available in steel, brass or 5056 aluminum and in seven standard styles with head diameters from 9/32 to 13/32-in. **Tubular Rivet & Stud Co.,** Wollaston (Quincy) 70, Mass.

—Circle ITEM 461

Switches and Relays

are moisture and dustproof

These hermetically sealed, moisture and dustproof rotary selector switches and stepping relays, applicable in aircraft, automation and electronics fields, are protected from the effects of salt spray, fungus and humidity. They are sealed in an inert atmosphere of dry nitrogen with a slight addition of helium tracer. Sealing is to Test 1 of MIL-R-25018. The units, which are capable of many switching combinations, are designed to facilitate installation and are protected against tampering with contacts or relay mechanisms. Relay illustrated qualifies for the requirements of shock, vibration, high and low temperatures, salt spray and acceleration outlined in MIL-E-5272A. Switches and relays are available in several standard enclosure sizes. Standard switches



Standard Quality sets Quality Standards

The day-in, day-out excellence, the quality which is standard in every Curtis Universal Joint, has made the Curtis Joint the quality standard of the industry.

Each Curtis Universal Joint component is made from specially selected steel, individually heat-treated for a specific purpose. This accounts for the long life and dependable performance of Curtis Universal Joints.

CURTIS UNIVERSAL JOINTS

- 14 sizes always in stock, ⅜" to 4" O.D.
- Fewer parts, simpler construction
- Complete equipment for government tests

Our catalog torque and load ratings are substantiated by constant tests. You can depend on them.

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK CURTIS

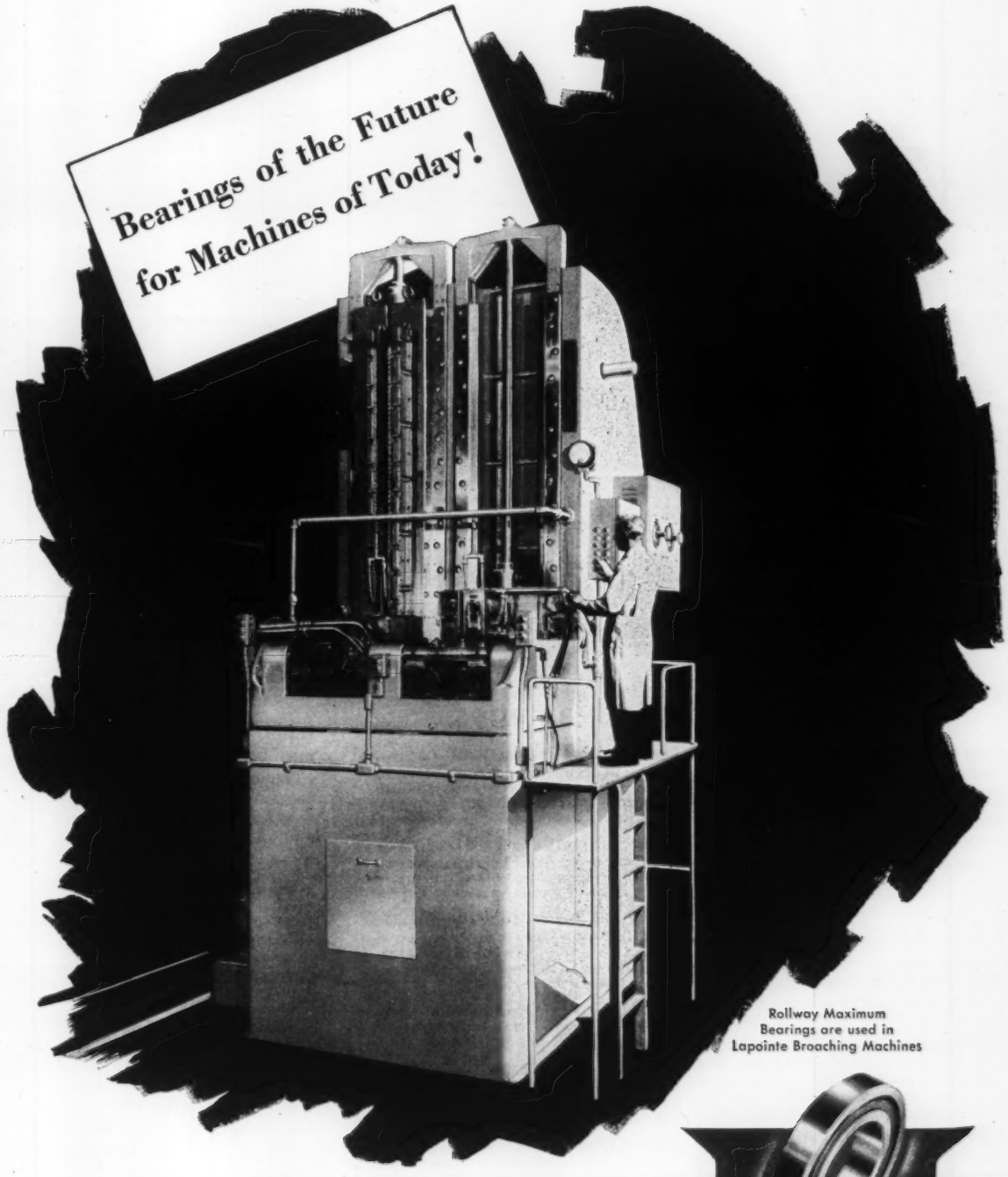
UNIVERSAL JOINT CO., INC.
5 BIRNIE AVENUE, SPRINGFIELD, MASS.

As near to you as your telephone

A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

—ITEM 582—

Bearings of the Future for Machines of Today!



Rollway Maximum Bearings are used in Lapointe Broaching Machines

Rollway roller bearings regularly offer performance capabilities for more than the needs of today. They are continuously anticipating the operating requirements of years ahead.

Wherever bearing precision and load values are important in your plant or products — for original equipment or replacement service — call on Rollway *bearings of the future,* to give you the utmost performance in your machines of today. Rollway Bearing Company, Inc., Syracuse 4, N. Y. Manufacturers of a complete line of radial and thrust cylindrical roller bearings.

ROLLWAY®
Maximum
ROLLER BEARINGS

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Milwaukee • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

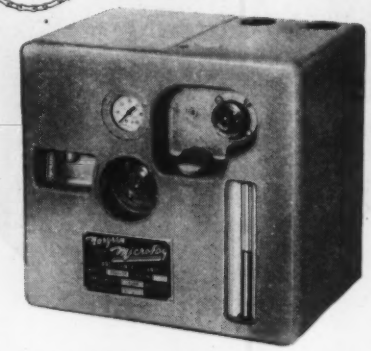
—ITEM 583—

DESIGN MEN

Latest Development in AUTOMATIC LUBRICATION

Norgren MICRO-FOG

Model 33AF-16
Lubro-Control Unit
For 1,000 Bearing Inches or less



Gives you these advantages

Only One Lubricator for 1,000 Bearing Inches—The 33AF-16 automatically creates a finely divided air-borne oil fog which can be appropriately distributed to all lubrication points of even large machines.

Better Lubrication—Continuously applies a protective film of oil—just the right amount, not too much, not too little—for the most efficient lubrication of machine components. Never periods of insufficient or excessive lubrication.

Oil Always Fresh, Clean—No recirculation of deteriorated or contaminated lubricant to increase wear or corrosion.

Big Savings Through Manifolding—MICRO-FOG can be manifolded the extent of any machine, greatly reducing the number of distribution lines or the number of lubricators required.

Eliminates Expensive High Pressure Piping—MICRO-FOG is distributed at pressures in the neighborhood of one p.s.i.

Big Savings in Equipment—Banishes large lubricant reservoirs, pumps, drainage and return lines, and elaborate filters of flood recirculating systems.

Lower Bearing Temperatures—Maintains lower operating temperatures of high speed rotating parts and eliminates heat from fluid friction generated by parts churning in lubricant.

Protection From Coolant and Dust—The slight air pressure in bearing housings prevents entry of coolant, abrasive dust or other foreign material.

Fewer Oil Seals Required—Because MICRO-FOG must be vented to the atmosphere, fewer oil seals are needed, reducing seal maintenance and machine down-time.

Visual Oil Feed—An oil feed dome provides a quick visual indication of proper operation of lubricator.

Automatic Alarm Controls—Switches are provided to actuate an alarm system or controls to warn of conditions affecting proper lubrication.

Space-Saving—Only 12" x 11" x 9" in size, this lubricator contains all necessary controls plus a 2-gallon oil reservoir.

Oil-Saving—With MICRO-FOG, every single particle of oil does a more thorough lubrication job. The 2-gallon reservoir holds enough oil for hours of continuous lubrication.

For complete data on Norgren MICRO-FOG 33AF-16 Lubro-Control Unit, call your nearby Norgren Representative listed in your telephone directory—or WRITE THE FACTORY FOR BULLETIN 531.

C. A. Norgren Co.

3442 So. Elati St., Englewood, Colorado

Pioneer and Leader in Oil-Fog Lubrication Since 1930

—ITEM 584—

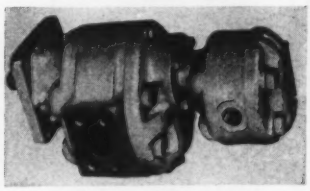
New Parts

have a maximum of four wafers and 105 pins in the header. **G. H. Leland Inc.**, 123 Webster St., Dayton, O.

—Circle ITEM 462

Tandem Hydraulic Pumps

deliver oil at two different pressures



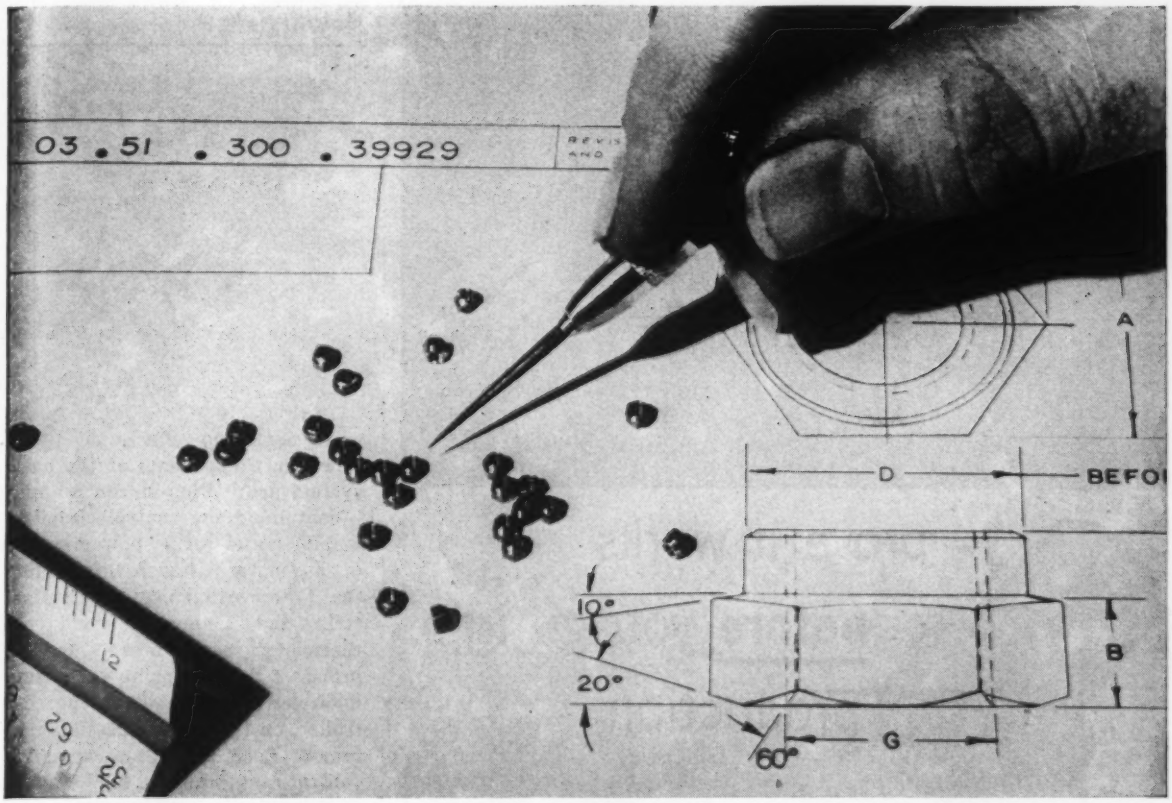
For application where two separate hydraulic circuits are required, such as in heavy-duty mobile equipment, Hydreco series 3000-2000 gear-type hydraulic pump delivers oil at two independent pressures and flow rates. The large pump section, 3000 series, operates at pressures to 1000 psi at 1200 rpm and delivers 36 to 64 gpm. The small pump section, 2000 series, delivers 10 to 25 gpm and may be used for auxiliary circuits. Pressure-balanced wear plate maintains fixed clearance with gear face regardless of pressure, reducing oil slippage to a fixed minimum. **New York Air Brake Co.**, Kalamazoo Div., P.O. Box 1069, Kalamazoo, Mich.

—Circle ITEM 463

Temperature Controller

uses thermistor for fast response, high sensitivity

Designed as a plug-in unit, series 53,000 thermistor-actuated temperature controller is used to assemble single or multipoint temperature control systems. The thermistor, which is the temperature sensing element for the unit controller, is a ceramic semiconductor which undergoes a large change in resistance per degree change in temperature. As a result, small temperature changes are accurately sensed, and the thermistor provides a large working signal which permits temperature control to 1 F or better. The sensing element can be 200 ft or more away from the controller



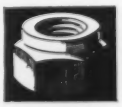
FLEXLOC MICROSIZE locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

Design Lighter, More Compact Products with New FLEXLOC Microsize Locknuts

Standard Microsize Locknuts Permit Design Engineers to Develop and Fasten Smaller Assemblies Safely

SIZE	Across Flats		Shoulder Height		Across Corners	Height +.000 −.003
	MAX.	MIN.	MAX.	MIN.	MIN.	
0-80 NF-3B	.111	.107	.047	.042	.123	.075
1-64 NC-3B	.127	.123	.0635	.0585	.141	.090
1-72 NF-3B	.127	.123	.0635	.0585	.141	.090
2-56 NC-3B	.158	.153	.068	.063	.176	.105
2-64 NF-3B	.158	.153	.068	.063	.176	.105
3-48 NC-3B	.190	.183	.071	.066	.210	.120
3-56 NF-3B	.190	.183	.071	.066	.210	.120
4-40 NC-3B	.190	.183	.072	.067	.210	.120
4-48 NF-3B	.190	.183	.072	.067	.210	.120

STANDARD MICROSIZE FLEXLOCs—in sizes ranging from 0-80 to 4-48—are available in brass (either plain or cadmium plated). Consult SPS for miniature nuts of other conventional materials.



New FLEXLOC Microsize locknuts are smaller and lighter than regular FLEXLOCs of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

Microsize FLEXLOCs have all the advantages of larger FLEXLOCs. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil, temperatures to 250°F won't affect these Microsize FLEXLOCs. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

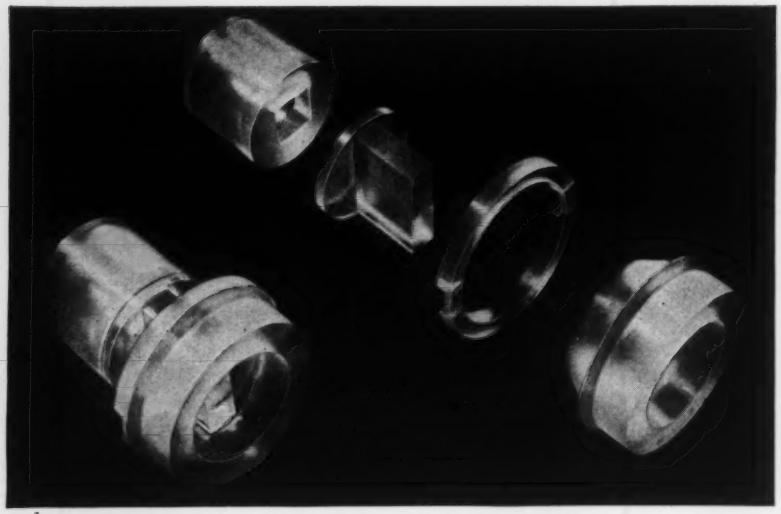
For complete information on Microsize FLEXLOCs, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

STANDARD PRESSED STEEL CO.

FLEXLOC LOCKNUT DIVISION SPS

JENKINTOWN PENNSYLVANIA

—ITEM 585—



prove it works **before** you go into production

Machine that part from polystyrene and let us investment-cast it in the metal you plan to use. Test it and, if some change is indicated, repeat the process until you have the final answer. This cut-and-try method of proving a design and an alloy saves you a lot of time and money.

Polystyrene machines readily and is inexpensive. Complex patterns can be made in sections and assembled, then cast as a unit just as they'd be investment-cast in quantity. Thus parts for testing are exactly like you'll get in production, but they cost far less than cutting them out of metal.

Technical Data Available

When your idea is on paper, but before you start to make the polystyrene patterns, send us a blueprint. We'll figure the shrinkage factor for you, suggest possible gating arrangements and design modifications which may effect further economies.

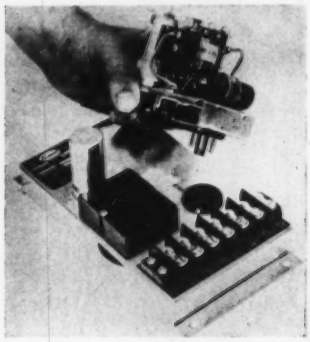
The pamphlet, *A Guide for Making Polystyrene Patterns*, describes methods of machining and names sources from which this material can be obtained. For a free copy, write Precision Metalsmiths, Inc., 1083 East 200th Street, Cleveland 17, Ohio.

pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

New Parts



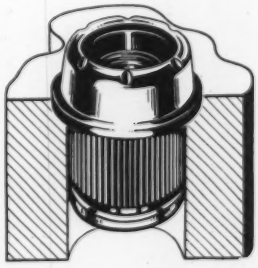
with negligible effect on signal strength. Components of the basic system are: Plug-in control unit —containing the control circuitry, amplifier and relay; power supply on a separate chassis—containing the power transformer, terminal strip and connectors; and the thermistor temperature - sensing probe. The setpoint adjusting knob can be mounted on the controller, on the power chassis, or at remote location. Representative control ranges offered are −100 to 50 F and 200 to 600 F; electrical ratings are 115 v ac, 5 amps noninductive and 230 v ac, 7 amps noninductive. **Fenwal Inc.**, Ashland, Mass.

—Circle ITEM 464

Spline Nut

is self-locking blind fastener for light alloys

Self-locking spline nut, type ND 2398, is an insert type fastener for aircraft and industrial applications where it is desirable to



have an attached nut for easy assembly and maintenance. Providing a tight grip in aluminum and magnesium alloys, it has a counterbored shank to accommodate AN thread length bolts. A chamfered pilot on the shank centers

Design "Low Cost" Into YOUR Equipment

GITS

World's Largest Selection of Low-Cost Lubricating Devices

ment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

Special Introductory Price
Just $14.95 F.O.B. Factory
Satisfaction or your money back

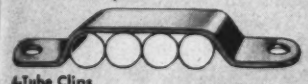
LIPS FOR ATTACHING UBING

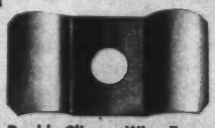
hen ordering, pecify ¼", ⅜" ¾" tubes. yle TF.

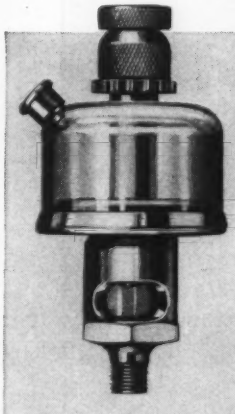
Single Clips

Double Clips

3-Tube Clips

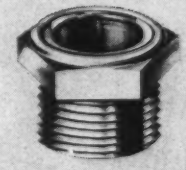

4-Tube Clips


Double Clips — Wing Type



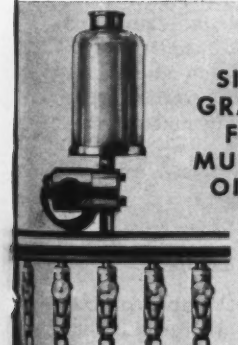
SIGHT GRAVITY FEED OILERS

Rate of oil flow regulated by needle valve, directly observed through sight glass in stem. Shut-off knob does not affect needle valve adjustment. Visible oil supply. Non-breakable. Tops in convenience and dependability, at low cost. Style NFU—No. 3602-A.



GEAR CASE GAUGES

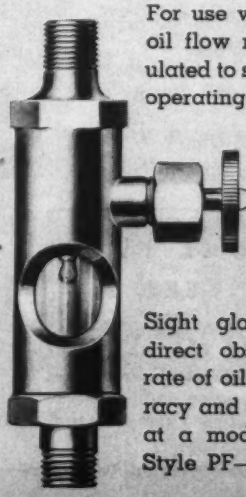
This oil gauge plug permits instant checking of oil level within a transmission or gear case. For use where construction permits insertion in tapped hole. A valuable addition to any such equipment — at very low cost. Style BW—No. 4042.



SIGHT GRAVITY FEED MULTIPLE OILERS

s one unit replaces 3 to 8 dividual oilers. Maximum cticality in a small central ication system. Positive cut- during idle periods. Individ- vibration-proof needle valve stments. With solenoid con- (Illustrated): Style MDS— 4685-A. Without solenoid:

SIGHT GAUGES



For use where rate of oil flow must be regulated to suit changing operating conditions. Needle valve permits extremely accurate adjustment of oil feed. Sight glass provides direct observation of rate of oil flow. Accuracy and convenience at a moderate price. Style PF—No. 4290.

Don't price yourself out of the market. When you design proper lubrication into your equipment, specify GITS Lubricating Devices—the widest selection available anywhere. The items pictured above are only a few of our many thousands of lubricating devices. At the design stage, get the GITS story. Free Engineering Service. Send NOW for your free Catalog.

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Chicago 23, Illinois

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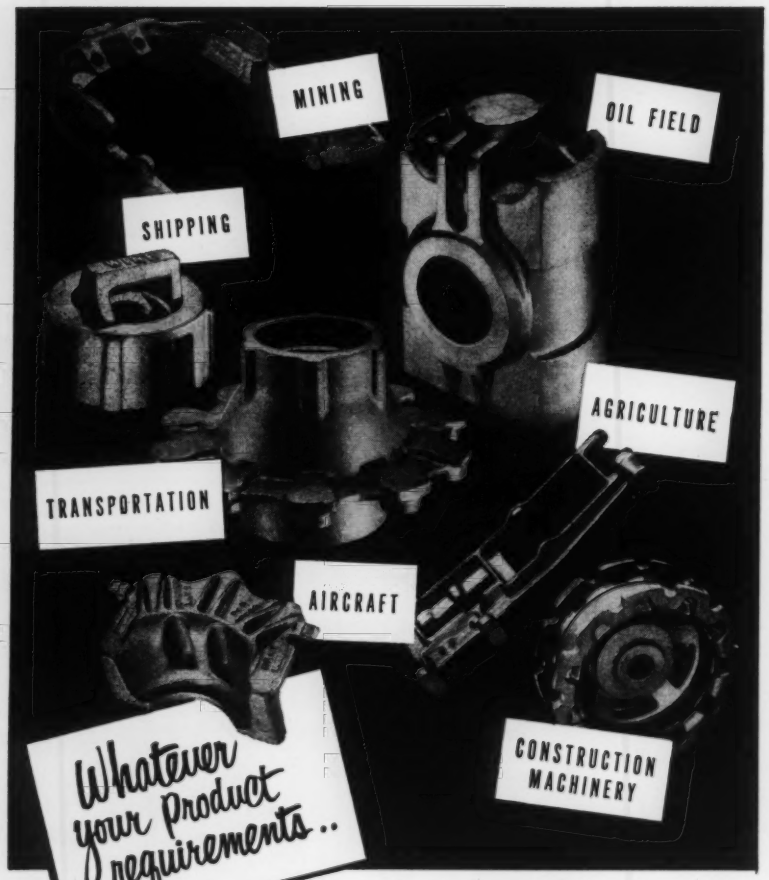
XUM



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WITH UNITCASTINGS!

We make no *special* claims to produce miracles with cast steel. Like competitive foundries, problems are similar . . equipment may differ slightly . . it's the *end performance* of the casting that counts!

A little *extra* surveillance in process pays off quality-wise. Customers receive better, cleaner castings . . meeting accepted specifications . . and end up with a lower *finishing* cost. Less scrap . . less re-work . and less lost production time amounts to more than incidentals!

Standard carbon and low alloy steel castings, up to 150,000 psi tensile . . whatever your requirements, specify Unitcastings!

UNITCAST CORPORATION • Toledo 9, Ohio

In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

QUALITY STEEL CASTINGS

—ITEM 588—

For More Information Circle Item Number on Yellow Card—page 19

New Parts

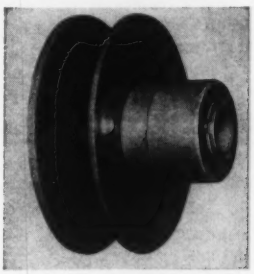
the nuts on insertion and ensures equal broaching of the installation hole by the splines. Nuts are available in sizes from 10-32 to ½-20; shank lengths vary with thread sizes from 0.156 to 0.562-in. **Elastic Stop Nut Corp. of America,** 2330 Vauxhall Rd., Union, N. J.

—Circle ITEM 465

Motor Pulleys

available in ½, ⅝ and ¾-in. stock bores

No. 30 and No. 40 variable-pitch motor pulleys, for use with A-sec-



tion belts are made of smooth-faced, noninterlocking, nonserrated machined cast-iron disks which eliminate excessive belt wear and pounding or vibration in the drive. Oil impregnated bushings on the pulley shaft eliminate greasing, and through-bores provide for applications requiring through-shaft mounting. No. 30 is rated 1/3-hp at 1750 rpm, has a 2:1 speed variation and is 3⅝ in. in diam, 2 13/16 in. long. No. 40 is rated ½-hp at 1750 rpm, has a 2.4:1 speed variation, 4 in. diam, and is 2 13/16 in. in length. Both pulleys are available in stock bores of ½, ⅝ and ¾-in. **Gerbing Mfg. Corp.,** 11800 Milwaukee Ave., Northbrook, Ill.

—Circle ITEM 466

Check Valve

controls water hammer

Flanged silent check valve controls water hammer in all types of hot or cold liquid service, including water, oils, gasoline, acids, chemicals, salt water and brine, where flow is constant. It has a removable renewable disk and seat and nonwear conical spring, and can

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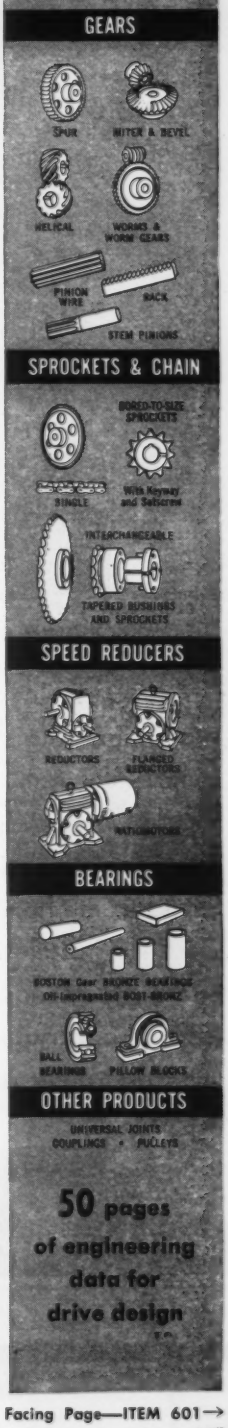

50 pages of engineering data for drive design

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NOW AVAILABLE FROM YOUR

BOSTON Gear DISTRIBUTOR

For nearest Distributor, look under "GEARS" in the Yellow Pages of your Telephone Book.

56BG-NC23

—ITEM 589—

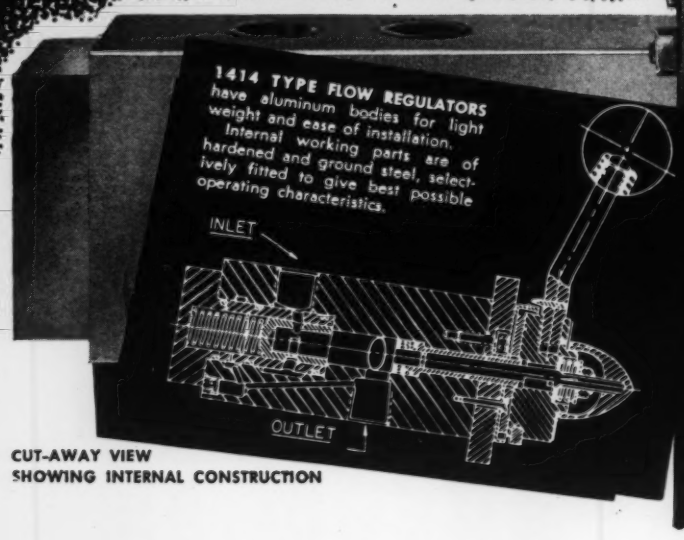
For More Information Circle Item Number on Yellow Card—page 19

Facing Page—ITEM 601→

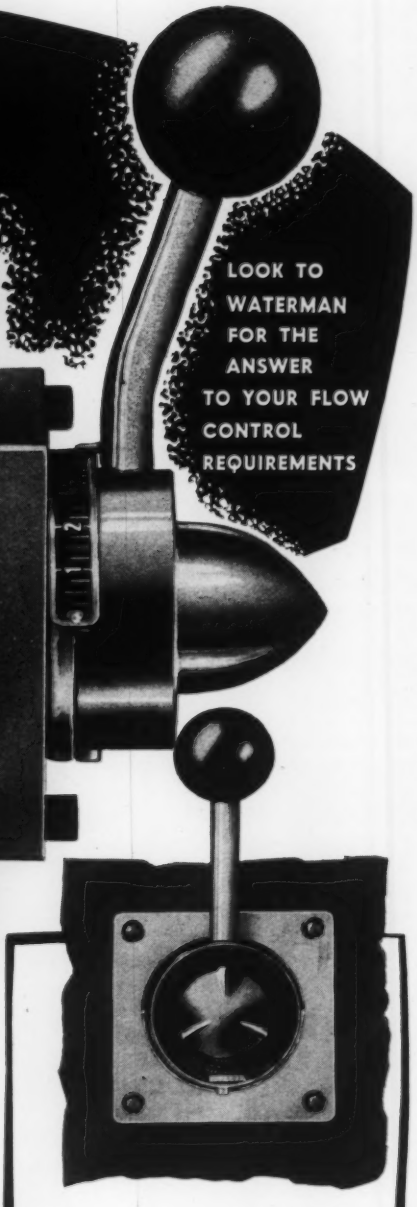
ADJUSTABLE FLOW REGULATOR

Designed for Panel Mounting

LOOK TO WATERMAN FOR THE ANSWER TO YOUR FLOW CONTROL REQUIREMENTS


1414 TYPE FLOW REGULATORS have aluminum bodies for light weight and ease of installation. Internal working parts are of hardened and ground steel, selectively fitted to give best possible operating characteristics.
INLET
OUTLET

CUT-AWAY VIEW
SHOWING INTERNAL CONSTRUCTION



Waterman Engineering Company have combined in this new Adjustable Flow Regulator all the best, improved features . . . at the same time adapting it to Panel Mounting.

Increases the flexibility of your hydraulic systems . . . ideal for installations requiring frequent changes in operating speeds.

Affords a variable adjustment of flow rate over a wide operating range.

Write for illustrated bulletin describing the many features of this Adjustable Flow Regulator such as right or left rotation of control handle, 180° handle rotation, pressure drop, regulated flow tolerance, etc.

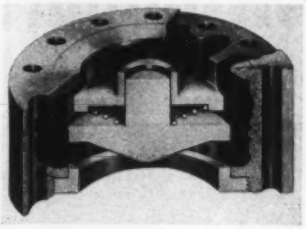
WATERMAN

ENGINEERING COMPANY

725 CUSTER AVENUE — EVANSTON, ILLINOIS

—ITEM 590—

For More Information Circle Item Number on Yellow Card—page 19

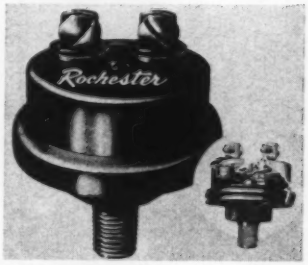


be used in any position. The valve is available in sizes from 1 to 10 in., faced and drilled in accordance with ASA standard for pressures ranging from 125 to 2500 lb. It can be furnished with special flange facings, including large male and female, ring joint, and large tongue and groove. **Williams Gauge Co. Inc.**, 2 Gateway Center, Pittsburgh 22, Pa.

—Circle ITEM 467

Vacuum Switch

resists vibration, pulsation and shock



Spring-loaded Buna-N impregnated diaphragm in this heavy-duty vacuum switch is protected against heavy vibration, pulsation and shock. Switch action at zero vacuum is either normally open or normally closed, and factory-calibrated vacuum settings to 22 in. Hg can be supplied. Switch is for use with 6, 12 or 24 v dc, in either single terminal grounded or double terminal models. Line connections are ¼ or ⅛-in. male pipe thread; overall measurements are 1¾ by 2 1/16 in. **Rochester Mfg. Co.**, 100 Rockwood St., Rochester 10, N. Y.

—Circle ITEM 468

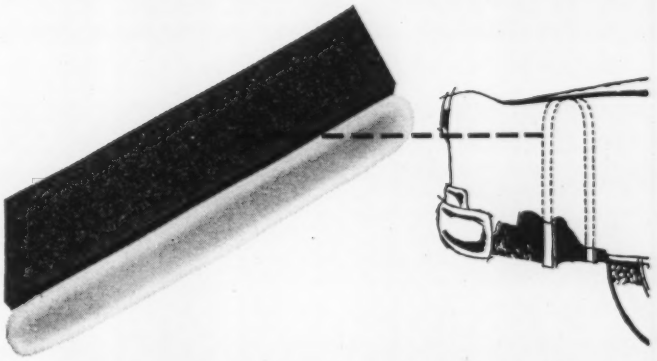
Tachometer

has pancake design

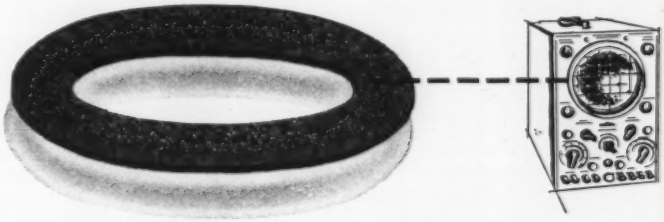
Wac-Tac tachometer, for use on integral horsepower motors and

(*Continued on Page* 162)

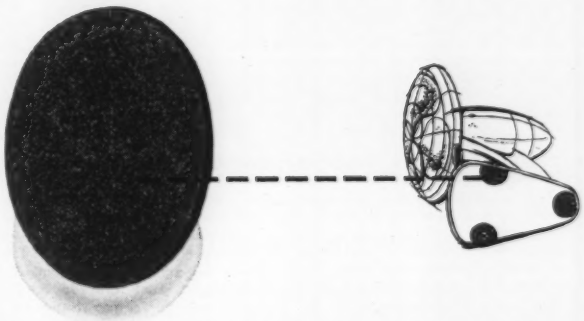
Prevents squeaks



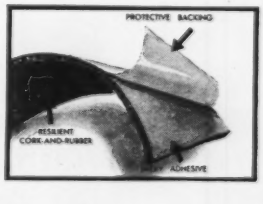
Absorbs shock



Stops vibration



Armstrong DK-153 is a resilient cork-and-sponged-rubber composition backed with pressure-sensitive adhesive. This versatile material is now being used for hundreds of different industrial jobs . . . including squeak-proofing metal-to-metal assemblies, cushioning glass-to-metal joints, and absorbing vibration. DK-153 comes in rolls, strips, sheets, or die-cut shapes, 1/32″ to 3/16″ thick. It's easy to apply: just peel off protective backing and press DK-153 in place. For samples, write on your business letterhead to Armstrong Cork Company, Industrial Division, 7307 Dean St., Lancaster, Pa.

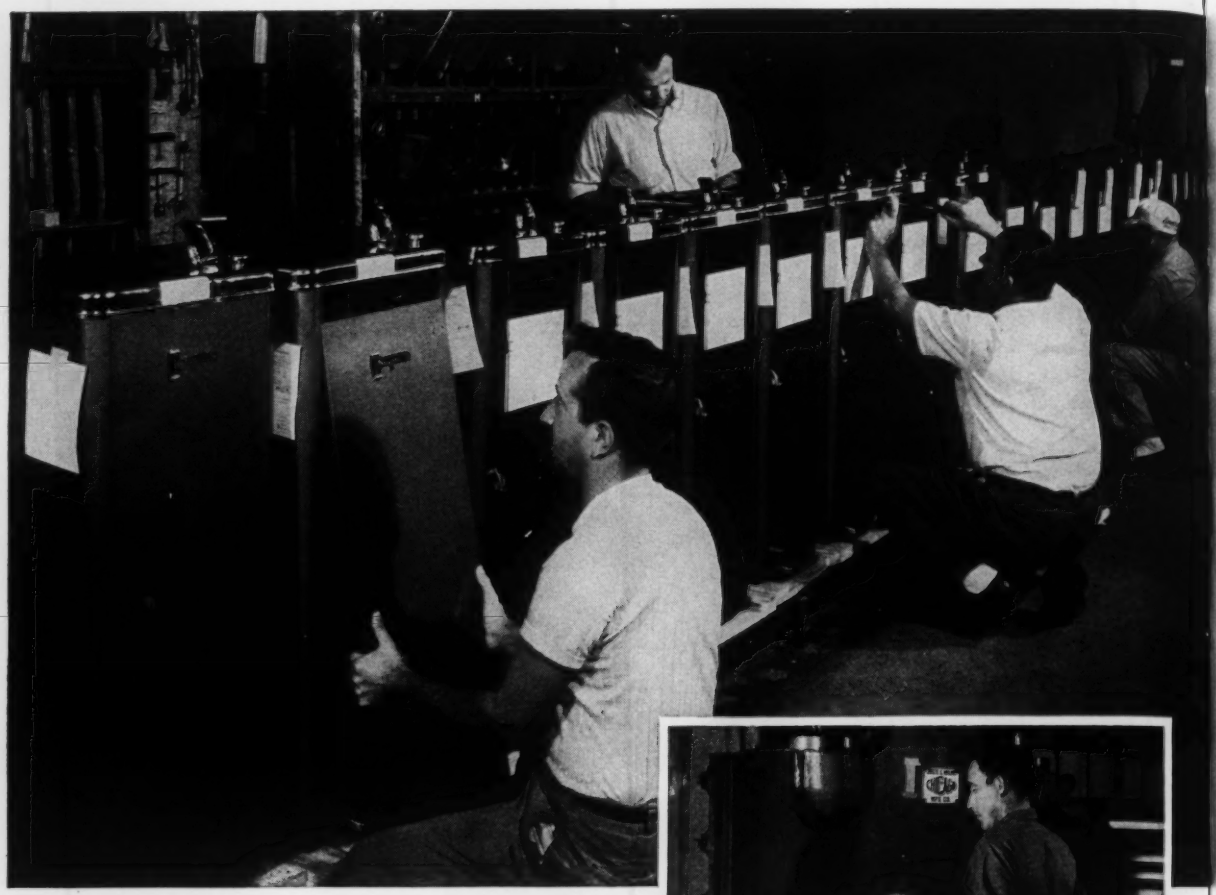


Armstrong DK-153

. . . used wherever performance counts

—ITEM 591—

Republic Electro Paintlok® doubles



ONLY ONE COAT OF PAINT on Republic Electro Paintlok, results in a handsome, durable finish for these Temprite water coolers. In addition, Republic ENDURO® Stainless Steel is used for fountain tops to provide life-time beauty and sanitation.

SEVERE FORMING AND BENDING are shrugged off by chemically treated, electro plated zinc surface of Electro Paintlok. In fact, the phosphate coating itself acts as a lubricant for certain forming operations. Send coupon for full details.

REPUBLIC

REPUBLIC STEEL®

World's Widest Range of Standard Steels

production of existing facilities

By using Republic Electro Paintlok instead of cold rolled sheet steel for their water cooler housings, Temprite Products Corporation of Birmingham, Michigan, actually double the output of their painting and drying facilities. How? Because only one coat of paint is used on these parts when fabricated from Electro Paintlok, and one pass through the drying oven is sufficient to produce a high-quality, long-lasting finish.

In contrast with this, uncoated sheets for this application required a prime coat before final painting. Temprite found, through experience, that the labor and material cost of the primer coat exceeded the extra cost of Electro Paintlok. Even more important, at today's level of demand *they could not maintain required volume of production when both a primer and final coat of paint had to be applied and dried.*

As a result, Temprite has standardized on Republic Electro Paintlok. And in addition to cost and time savings, they secure a higher quality finish as well. Even when scratched through, Electro Paintlok's chemically treated zinc surface continues to retard corrosion and effectively limits it to the point of original damage.

Add all of these advantages to the fact that Electro Paintlok is delivered from the mill in prime condition for painting and will not rust under approved warehousing conditions . . . and you can see why it will pay you to investigate its use wherever you have a paint adherence problem. Simply contact your Republic representative or mail the coupon for full information.

BUILT-IN SALES APPEAL for the Temprite Club Bar, four-beverage dispenser, is secured through the use of ENDURO Stainless Steel for all housing components. The lustrous beauty of ENDURO harmonizes with any surroundings . . . stays bright and sanitary indefinitely without laborious polishing. Republic makes all analyses of stainless to meet every application. Coupon will bring full information by return mail.

PRODUCTION PROBLEMS VANISH when you specify Republic Steel Sheets. Whatever your requirements, your Republic representative or steel distributor can help you select the ideal type of sheet. He is backed by a broad selection including hot rolled, cold rolled, continuous galvanized, Galvannealed, Electro Paintlok, Electro Zincbond®, Electro Flashcote and other types in a wide variety of analyses.

END PRODUCTION BOTTLENECKS by sending your sheet steel fabricating problems to Republic's Berger Division. You get the benefit of complete contract fabricating facilities, plus a wealth of experience, designed to form high-quality sheet steel into products or components of your own design, *economically*. Investigate this means of cutting tooling costs and plant additions. Mail the coupon for further data, today.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
Dept. C-1034A
3130 East 45th Street, Cleveland 27, Ohio

Please send me further information on:
- ☐ Republic Electro Paintlok
- ☐ Republic ENDURO Stainless Steel
- ☐ Berger Division Contract Manufacturing Facilities
- ☐ Republic Sheet Steel (specify) _____

Name _____ Title _____
Company _____
Address _____
City _____ Zone _____ State _____

—ITEM 592—

THIS IS IT!

The Quick-Connective Pneumatic Coupling that gives you these big advantages . . .

EFFECTIVELY HANDLES MORE VOLUME THAN ANY OTHER COUPLING OF EQUAL DIMENSIONS
CAN BE USED ON ANY CIRCUIT WITH 3/4" TO 1/8" CONNECTIONS
ONE-WAY SHUT-OFF
HANSEN
OPEN

HANSEN Series 3-RL

RING-LOCK COUPLING

• Compactly designed, the Hansen Series 3-RL Coupling *effectively* handles far more volume than any coupling of equal dimensions. On units where several air circuits are required, the single-size Series 3-RL Coupling—with correct size connections—can be used on any line with 3/4" to 1/8" fittings—thus making it easy to keep stock of parts in balance—hold inventories to a minimum.

To connect, merely push Plug into Socket. To disconnect, just turn the sleeve—flow is shut off instantly and automatically. Locking ring provides positive lock and assures tight fit.

Representatives

BALTIMORE
BIRMINGHAM
BUFFALO
CHICAGO
CLEVELAND
DALLAS
DAYTON
DENVER
DETROIT
FT. WAYNE
HARTFORD
KANSAS CITY
LOS ANGELES
LOUISVILLE
MILWAUKEE
MINNEAPOLIS
NEWARK
NEW ORLEANS
PHILADELPHIA
PITTSBURGH
SAN FRANCISCO
SAVANNAH
SEATTLE
ST. LOUIS

MONTREAL • TORONTO • VANCOUVER
Export Department: Cleveland

WRITE FOR CATALOG
QUICK CONNECTIVE FLUID LINE COUPLINGS *for*
AIR • OIL • GREASE
HYDRAULIC FLUIDS • WATER
VACUUM • STEAM • OXYGEN
ACETYLENE • REFRIGERANTS
GASOLINE • COOLANTS

SINCE 1915 — QUICK CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

—ITEM 593—

New Parts

(*Continued from Page* 159)

automatic machinery, delivers ac voltage with frequency and magnitude linear with speed. Generator sinusoidal voltage is as high as 25 v per 100 rpm, and frequency change is 30 cps per 100

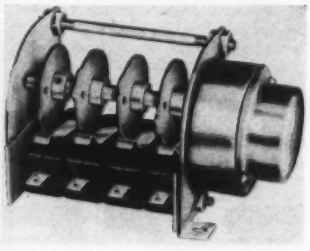
rpm. No slip rings, brushes or contacts are employed. Thin pancake design of the unit provides minimum protrusion beyond the machine to which it is attached. Designated Model 5, it can be adapted for mounting within the frame of a motor or machine, or for external attachment. **WacLine Inc.**, 35 S. St. Clair St., Dayton 2, O.

—Circle ITEM 469

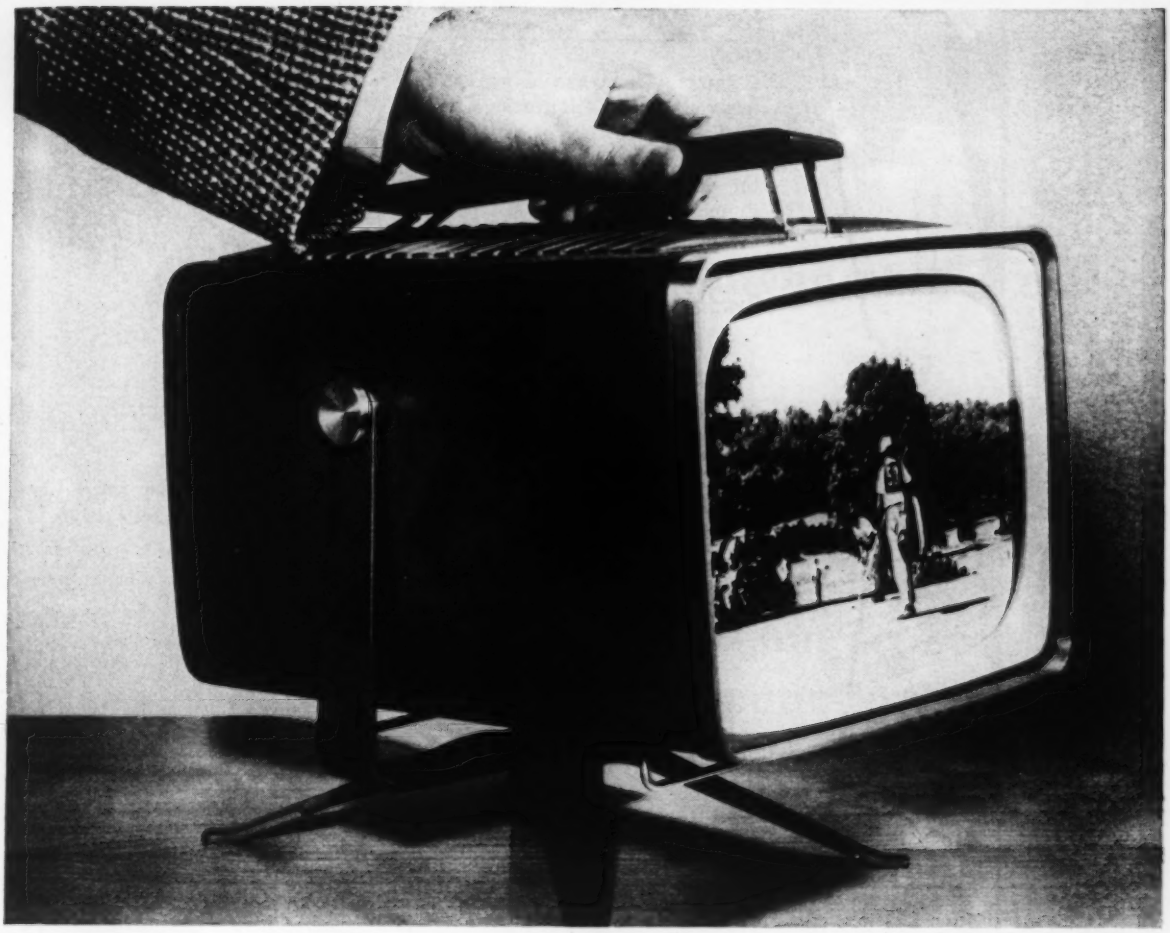
Repeat-Cycle Timer

constructed to user's multicircuit control needs

A wide variety of switch combinations and cam speeds are available in this low-cost, multicircuit repeat-cycle timer. The unit is made to specifications and utilizes a standard synchronous timing motor and snap-action enclosed



switches rated at 15 amp, 125 v ac. Cam speeds range from one revolution per second down to one revolution per month. Enclosed construction provides dependability and accuracy. The unit shown is approximately 3 in. high, 2 in. wide and, with four switches, is 4



New personal portable TV by RCA Victor is only slightly larger than a table model radio. Coating based on BAKELITE Vinyl Resins formulated by **John L. Armitage & Company,** Newark, New Jersey.

Tough textured coating

for TV that travels

"In designing the personal TV, it was apparent that by its very nature the versatile set would be used in a variety of locations—patios, recreation rooms and kitchens. An attractive, durable, scuff-resistant finish was needed. RCA Victor selected a coating based on BAKELITE Brand Vinyl Resins. Colored, textured and tough, this finish withstands the demanding wear of portable usage."—*A report from RCA Victor.*

Have a new product problem in coatings? A wide selection of coatings based on BAKELITE Brand Vinyl Resins may provide the answers. These finishes give long-lasting protection against corrosives, temperature extremes, abrasion and destructive atmospheres.

If you would like a list of suppliers of coatings based on BAKELITE Resins and a free copy of our booklet, "Coatings for General Industry," write Dept. RZ-103.

BAKELITE BRAND RESINS for COATINGS

Vinyl, Phenolic, Epoxy, and Styrene Resins for Coatings

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC

—ITEM 594—

For More Information Circle Item Number on Yellow Card—page 19

KARAK

Non-metallic material or parts for manufacturing your product. "KARAK" is manufactured in various combinations of graphite and carbon. To suit your requirements any combination of these materials can be impregnated. Bearings - rings - molds and cores - seals for liquids - air and grease pumps - Diesel engines - air compressors, etc., represent only a partial list of applications. Day by day many needs are developing in industry where this type of material is found to be superior to materials now being used.

DESIGN WITH "KARAK" IN MIND

We welcome your inquiries!

Basic Manufacturers

THE OHIO CARBON COMPANY

12500 BEREA RD., CLEVELAND 11, OHIO

—ITEM 595—

New Parts

in. long. Timer can be used in industrial control applications, vending machines or in appliances. **Vocaline Co. of America Inc.**, Bristol Motor Div., Old Saybrook, Conn.

—Circle ITEM 470

Bendable Tubing

is easily installed

Three-ply Plica tubing, made in almost any desired combination of ferrous and nonferrous metals,

fiber, paper and other materials, has high wall strength, watertightness and sharp bending radii. Sizes available range from $\frac{3}{8}$-in. through 2 in. ID. Typical applications include lubricating, coolant and other noncorrosive liquid lines, hot and cold air ducts, mechanical protection and insulation of pipes, flexible shaft casing and a wide variety of other uses. Since it can be cut with a hacksaw or knife, can be bent by hand, and fits all standard connectors, installation time for the tubing is substantially reduced. **Flexaust Co.**, 100 Park Ave., New York 17, N. Y.

—Circle ITEM 471

Wire Marker

withstands temperatures to 375 F

Self-sticking aluminum foil wire marker has high resistance to oils and solvents. Three mils in thickness, it conforms to wires without bulking and withstands constant operating temperatures to 375 F. Legend is imbedded in full, soft aluminum for positive wire identification. Markers do not curl or slip off oily wires, and do not dis-

The abbot and the "Popping Plugs"

The *abbot* re-read the note, "Electronic Computer Manufacturer "X" is having trouble keeping plugs from popping out of jacks. Complex servomechanisms and controls are being thrown out of whack as a result. Sound interesting?"

The abbot's Solution: Use an Abbott bearing ball as a spring-loaded detent ball to hold the plug securely in its receptacle. Result: 20 lbs. pull needed to remove it, *and* an end to the problem of the "popping plugs."

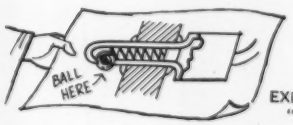


EXHIBIT "A"

Abbott carbon steel bearing balls serve many needs because they are Deep Hardened and Tempered. This makes them perform efficiently under high load factors and gives them increased shock resistance. These qualities amply justify the name . . . ABBOTT – "the Ball with the Armored Heart."

Want to learn more about the little man – and how he can help you? Drop a line to . . .

ABBOTT

The ABBOTT BALL Company

50 Railroad Place, Hartford 10, Conn.

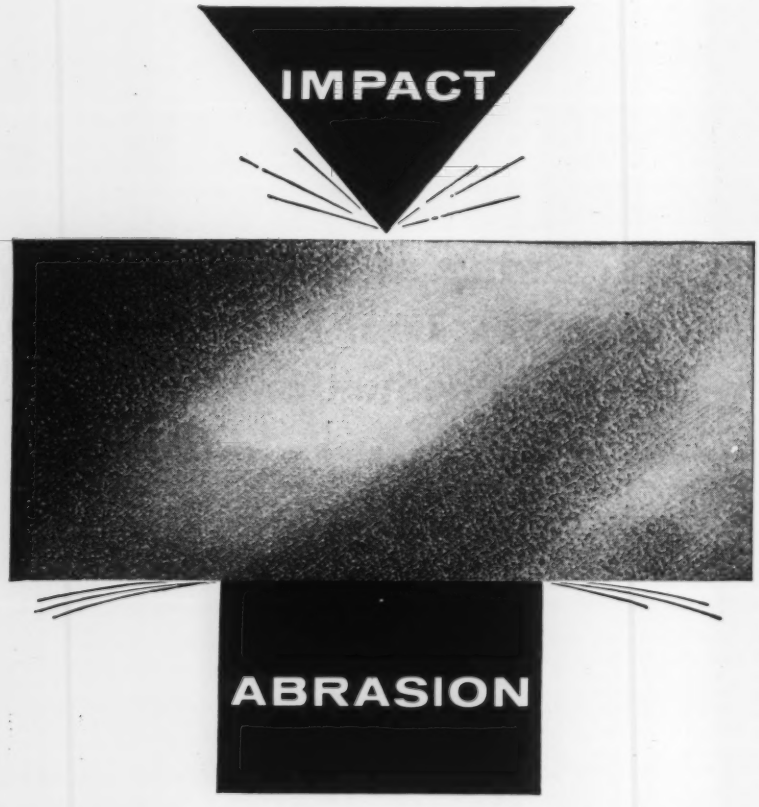
—ITEM 596—

The
Free Machinability of
EATON
PERMANENT MOLD
GRAY IRON CASTINGS
permits Machining at Higher Feeds and Speeds, gives Longer Tool Life with resulting Production Savings
Eaton Permanent Mold Gray Iron Castings are free from inclusions and hard spots, permitting higher machining feeds and speeds, and substantially increasing tool life.
Characteristics of these castings include a dense non-porous structure, excellent tensile strength, and freedom from leakage under pressure. Eaton castings are ideal for such important automotive and appliance components as compressor bodies, hydraulic cylinders, gear blanks, bearing retainers, pump bodies, pulleys, and countless others.
We will be glad to discuss the advantages of Eaton Permanent Mold Gray Iron Castings with your engineers.
FOUNDRY DIVISION
VASSAR, MICHIGAN

AMSCO®

MANGANESE STEEL

the toughest steel known for...



Amsco Manganese Steel actually *absorbs impact energy*. Impact work-hardens the steel's surface to as high as 550 BHN, while retaining high *ductility* beneath the hardened surface. This is a tough steel with the superior ability to *resist abrasion*. The more it is used, the harder and more polished the surface becomes. These are the characteristics of manganese steel that minimize wear and reduce the need for frequent lubrication.

The slow *crack propagation* rate of the steel allows for an *early discovery* of impending failure, even at arctic temperatures.

For a *complete technical discussion* of this high-strength "toughest steel known," write for *your* free copy of booklet, *Austenitic Manganese Steel*, Amsco Division, Chicago Heights, Illinois.

AMERICAN Brake Shoe COMPANY

AMSCO

American Manganese Steel Division

Chicago Heights, Ill.

—ITEM 598—

New Parts

color. They are coated with a silicone plastic overcoating to protect against abrasion and to shed grease, water and dirt. The markers are furnished in 235 stock numbers, letters and symbols including NEMA, ASA and Machine Tool Control codes. Two stock sizes are available: 1½ in. long markers for wires over ¼-in. OD and ¾-in. markers for wires under ¼-in. OD. **W. H. Brady Co.**, 727 W. Glendale Ave., Milwaukee 9, Wis.

—Circle ITEM 472

Subminiature Relay

withstands 50-*g* shocks, 125 C temperatures

Weighing approximately 1 oz and measuring 1.77 in. long by 0.651-in. diam, this two-pole, hermetically sealed subminiature relay

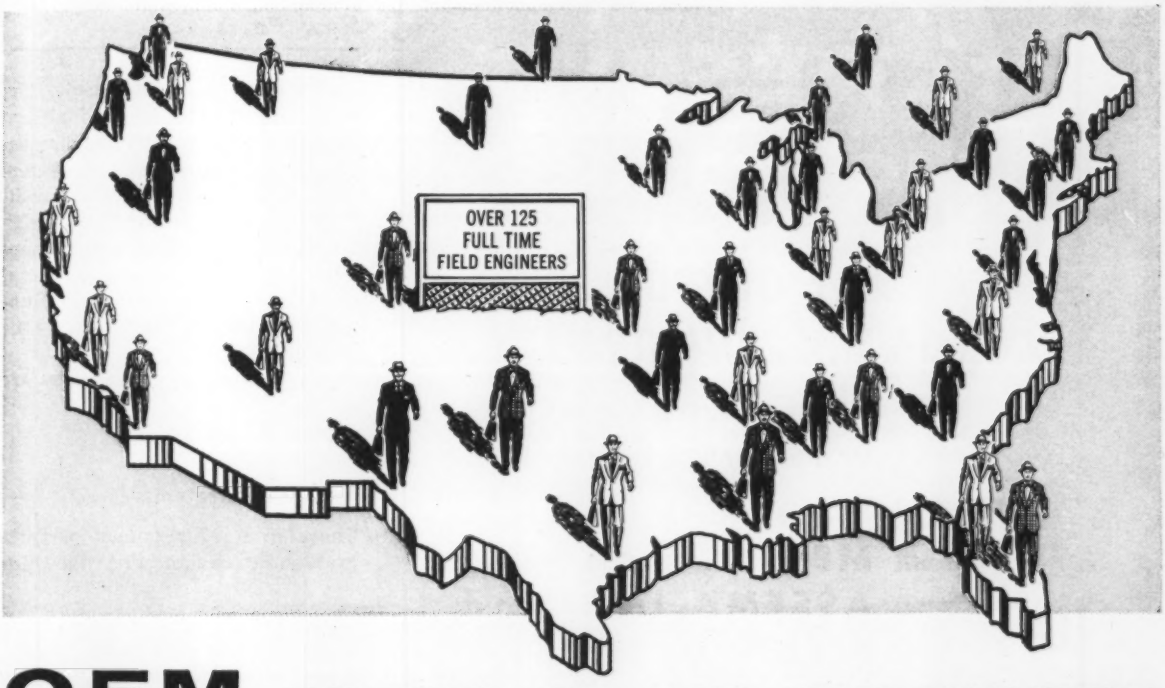
withstands shocks in excess of 50 *g*'s and ambient temperatures as high as 125 C. Operating current for the 480 ohm coil is 350 milliwatts. Coil withstands 40 per cent over-voltage continuously at ambient temperatures to 125 C. Contact rating is 2 amp (resistive) at 28-v dc or 115-v ac. Operating time with normal coil voltage is less than 10 millisec; dropout time is less than 6 millisec. Relay is intended for electronic applications in aircraft, aboard ship and in mobile units. **General Electric Co.**, Specialty Control Dept., 1 River Rd., Schenectady 5, N. Y.

—Circle ITEM 473

Rubber Compound

has softness characteristic of 5 durometer

Compound RRD-992 is a soft, nonporous, solid rubber that can be securely bonded to metal. It has a softness characteristic of 5 durometer and is applicable in temperatures up to 200 F. A reasonably good electrical insulator, it can be vulcanized or bonded



OEM USERS OF AIR CYLINDERS

have available Bellows Nation-Wide Field Service

Original equipment manufacturers incorporating fluid power circuits in their products to meet the growing demand for higher output and lower cost face two problems:

Original Design . . . and Field Service

Bellows Air Motors and other Bellows "work devices" lend themselves readily to OEM design. For example, all operating valves, actuating elements, speed control regulators are built into the units, simplifying circuit and installation problems. All units are compact, streamlined, fit well into crowded quarters. All units can be positively interlocked with reciprocating machine elements.

More than 125 Bellows Field Engineers devoting their full time to the sales and service of Bellows equipment. One or more Field Engineers in every major industrial area in the United States and Canada . . . and in Australia, Europe and the British Isles provide certain assurance that any service requirement on any Bellows unit will be handled promptly.

And of equal importance — every Bellows Field Engineer is fully capable of working with you and your engineers in developing the most effective and most economical way of incorporating "fluid power" control and operation into your product.

We have prepared a new booklet showing a little of the widespread usage of Bellows Air Motors and related "fluid-power" devices in many OEM products. It makes interesting reading for the manufacturer looking for ways to increase the productive efficiency of his product. It is free on request. Write Dept. MD756, The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto, Ontario.

1425A

The Bellows Co.
AKRON 9, OHIO

—ITEM 599—
For More Information Circle Item Number on Yellow Card—page 19

It's RESULTS that count!

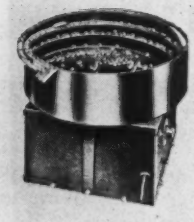
Speedier OUTPUT... ECONOMY... UNIFORMITY

That's what you get when you use

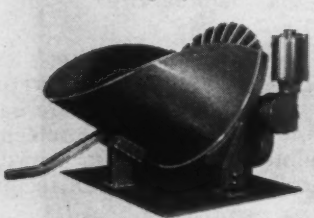
DPS POWER METHODS on your ASSEMBLING and FEEDING JOBS

Let these mechanical helpers bring you more profitable results.

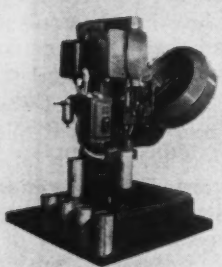
Write Today, ask for Catalog!



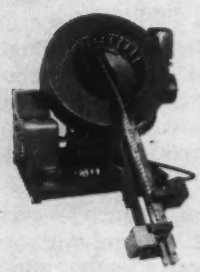
BOWL FEEDER
Vibratory type, to select and feed smaller fragile parts.



BARREL FEEDER
with stationary ring cover, for heavy-duty, large production runs



SPECIAL ASSEMBLING MACHINES
For light assembly operations using Selective Parts Feeders to feed component parts



BARREL FEEDER
Conventional type, for parts requiring critical selection

5 SCREWDRIVING MACHINES
Bench and Pedestal types. Pedestal Model A pictured

DETROIT POWER SCREWDRIVER CO.

2801-A W. FORT ST. DETROIT 16, MICH.

New Parts

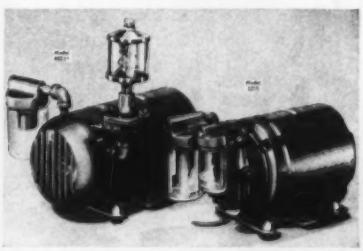
to metal and other materials. The compound can be used to absorb vibration and shock, to dampen sound, or as an airtight or watertight gasket. The rubber is available separately in sheets or strips up to 1 in. thick, or can be supplied molded or bonded to metal to meet requirements. **Roth Rubber Co.,** 1860 S. 54th Ave., Chicago 50, Ill.

—Circle ITEM 474

Rotary Air Pumps

are lightweight, vibration-free units

These rotary air pumps of integral-motor design are one-third



lighter than former models and are suitable for use in industrial instrument and control systems, printing and photo - engraving equipment, and as portable laboratory air sources. Model 0211, with 1/6 hp motor, weighs 22 lbs and has a resilient, rubber-cradled motor mount for quiet, vibration-free operation. It delivers up to 1.3 cfm (free air test) at 1750 rpm, with vacuums to 27 in. or pressures to 25 psi. Model 0321 delivers 2.2 cfm with ¼ hp motor, vacuums to 28 in. or pressures to 25 psi. For air volumes to 3.8 cfm, model 0521 (1/3 hp motor) is recommended. Both large models are forced-air cooled for continuous service at moderate temperatures. **Gast Mfg. Corp.,** P. O. Box 117, Benton Harbor, Mich.

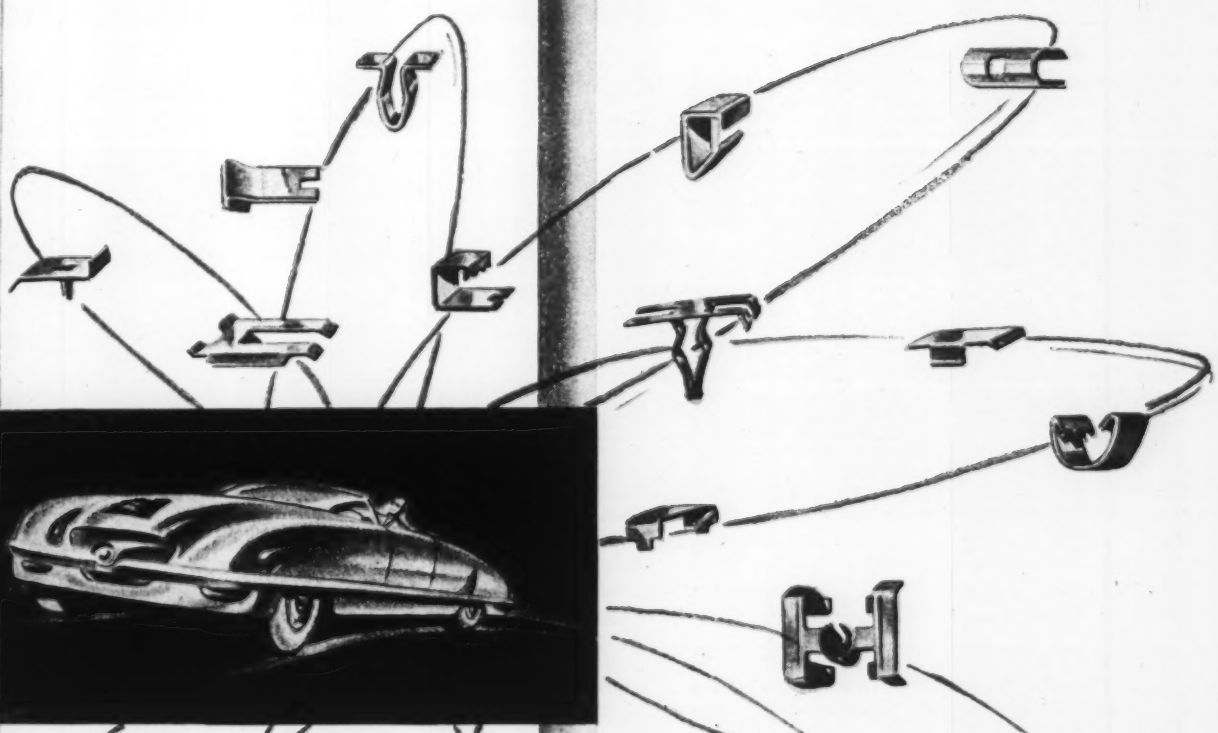
—Circle ITEM 475

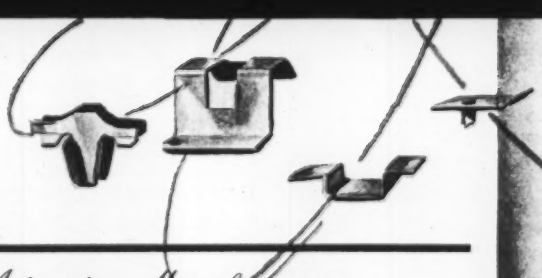
Electrical Power Package

is 400-cycle auxiliary supply for aircraft application

This hydraulic-powered electrical power package for airborne installations provides 400-cycle ac for electronic equipment added to air-

If you're part of the AUTOMOTIVE Industry you should know about SHARON SPECIAL STEELS





Automotive Manufacturers

Should Have These Booklets:

430 STAINLESS — a complete review of a popular straight chromium grade.

GALVANITE* — The story of one of the most popular hot dip zinc coated steels.

SHARONART* — Rolled-in design steels with excellent illustrations.

SHARONSTEEL

*Trademark registered by Sharon Steel Corporation

Since the beginning, Sharon has been a prime supplier of the steels needed most by the automotive industry. Sharon produces hot and cold, flat rolled special strip steels in large coils, cut lengths or sheets especially for truck, motor car and bus manufacturers.

If you want exactly the right steel for the job, why not call in the man with automotive steel experience—your Sharon Steel Salesman.

Typical Sharon products used by leading automobile and automobile parts manufacturers include:

STAINLESS
both straight chrome and chrome-nickel

SPRING STEELS
of every analysis

SHARONART
the steel with the rolled-in design surface

COATED STEELS
Galvanite* Brite Zinc-Electro Galvanized - Terne

N.A.X. and COR-TEN
hi-tensile low-alloy steel

FORGING INGOTS and BILLETS

PLATES

SHARON STEEL CORPORATION *Sharon, Pennsylvania*

District Sales Offices: Chicago, Cincinnati, Cleveland, Dayton, Detroit, Grand Rapids, Indianapolis, Los Angeles, Milwaukee, New York, Philadelphia, Rochester, San Francisco, Seattle, Montreal, Que., Toronto, Ont.

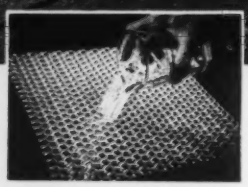
XUM

Cambridge

WOVEN WIRE CONVEYOR BELTS

take the bottlenecks out of

WASHING, DRYING, PACKAGING



OPEN MESH of rustproof, all-metal belt provides free circulation of process solutions and drying air; assures waste-free packaging.

Whether you're processing slab, sheet or pelletized materials . . . or packaging bottles, drums or bags . . . Cambridge Woven Wire Conveyor Belts combine movement with processing. Continuous belt-to-belt flow through washing and drying cycles, roasting kilns, and weighing and sealing operations cuts cost and provides controlled uniform production.

REGARDLESS OF YOUR INDUSTRY . . .

. . . metalworking, food, chemical, ceramic or glass . . . whether the machines are for your own operation or resale, you'll find "open mesh" only one property of Cambridge belts that makes combined movement and processing practical and economical. Open mesh construction also provides rapid drainage of process solutions. Belts are corrosion resistant and impervious to heat damage, even at 2100°F. They have no seams, lacers or fasteners to wear more rapidly than the body of the belt. Cambridge Woven Wire Belts are made in any size, mesh or weave; from any metal or alloy. Special surface attachments are available to hold products during inclined movement.

Call in your Cambridge FIELD ENGINEER to discuss how you can cut costs by continuous operation. Look under "BELTING, MECHANICAL" in your classified phone book. OR, write for FREE 130-PAGE REFERENCE MANUAL giving mesh specifications, design information and metallurgical data.

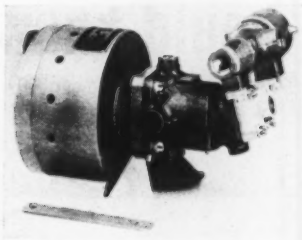
The Cambridge Wire Cloth Company

WIRE CLOTH · METAL CONVEYOR BELTS · SPECIAL METAL FABRICATIONS

Department N
Cambridge 7, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

New Parts



craft electrical systems already loaded to capacity. Consisting of a permanent-magnet, ac generator directly driven by a flange-mounted, constant-speed oil-hydraulic motor, the unit maintains 400-cps frequency within ±0.1 per cent, regardless of load. Generator is a 120/208 v, three-phase, wye connected unit developing 400 cps at 8000 rpm. It is capable of continuous duty at altitudes to 55,000 ft and ambient temperatures from −65 F to 250 F. The constant-speed hydraulic motor is a fixed-stroke, axial-flow, piston-type aircraft unit. Designed for use with systems having maximum operating pressures up to 3000 psi, the motor has a high power to weight ratio and overall efficiency in excess of 92 per cent. The power packages are available in six sizes for 0.5 to 3.0 kva outputs. The 1-kva package (shown) weighs 10.5 lb, as compared with 38 lb for a conventional inverter. Overall efficiency of this unit is 62 per cent. **Vickers Inc.**, 1400 Oakman Blvd., Detroit 32, Mich.

—Circle ITEM 476

Flexible Shafts

have torque ratings to 250 lb-ft

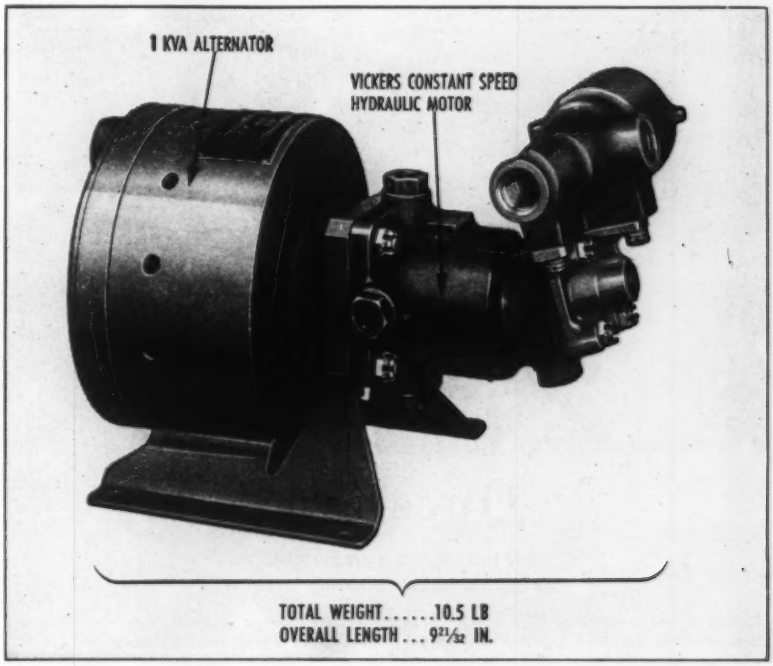
Cores of these flexible shafts, designed for remote control of valves, are made of multiple layers of precision-wound high-carbon wire. Casing is interlocked metal, asbestos packed, and is available in either galvanized steel or phosphor bronze. Supplied with a variety of terminals, the shafting permits valve control from almost any remote point. Plain valve couplings that can be fastened to the valve handwheel spokes are available in different types: one for rising handwheel valves, one for rising-stem gate valves, and one for nonrising

New Vickers Airborne Electrical Power Package

. . . Saves Weight and Space

Utilizes the Hydraulic System for More Efficient Production of AC Power

This new isolated electrical power package provides closely regulated AC power with minimum weight and envelope while drawing its power from a hydraulic system. In new designs or when adding electronic equipment to aircraft designs in which the electrical system is already loaded to capacity, this versatile package provides the needed AC power from flow available in the hydraulic system. This generally is permissible without system change as the full flow is seldom demanded except for a few seconds under rare circumstances. Even in such cases, full flow can be guaranteed to these hydraulic functions through the use of a simple priority valve which starves the AC power package momentarily.



Less Weight and More Efficient

Important weight savings are achieved through the use of this package instead of an inverter which may also require an increase in the DC generator and line capacities. In one instance, the 10.5 lb 1 kva package replaced a 38 lb inverter for co-pilot instrumentation. An additional advantage is that the package has 62% overall efficiency while that of the inverter was 35-40%.

Extreme altitude operation is no problem as the Vickers isolated electrical power package contains no brushes or other altitude-sensitive components.

Features of AC Generator

The permanent magnet type AC generator has excellent life and reliability. It requires no bulky voltage regulator . . . is inherently smaller and lighter than conventional generators due to the elimination of the exciter and slip rings. It also has higher overall efficiency resulting from elimination of all excitation losses. Additional advantages are that the permanent magnet is unaffected by momentary short circuit, or separation of field and armature without keeper, or by temperature cycling. It is also not susceptible to aging or shock. This unit is 120/208 volt, three phase, wye connected with 400 cps at 8000 rpm. It is capable of continuous duty under environments of 0-55,000 feet altitude and ambient temperatures from −65 F to 250 F.

Hydraulic Motor Drive

The generator is directly driven by a Vickers Constant Speed Hydraulic Motor having fixed stroke and an integral flow control valve that maintains an 8000 rpm speed setting within ±2½% regardless of the load (as long as valve inlet pressure is greater than load requirement). For the unit shown above, maximum operating pressure is 3000 psi while rated output of 1 kva requires operating pressure of 2200 psi. Special configurations will maintain 400 cps frequency within ±0.1% regardless of load. This motor has a very high horsepower-weight ratio and its overall efficiency exceeds 92%. It is a time-proved design capable of many hundreds of hours of continuous service without attention.

Many Uses and Sizes

The applications for this isolated power source are numerous. For multi-engine aircraft, its use for co-pilot instruments provides dual reliability. This package has been used to supply controlled frequency AC power in emergencies when the only source of power in the airplane is a ram air turbine driven pump. The efficiency of this arrangement minimizes the size and weight of the ram air turbine necessary to provide emergency hydraulic and electric power. 7492

Now available in the sizes listed below, larger packages can also be supplied from existing components. Vickers is prepared to develop the package best suited to a specific need. For further information, write for bulletin A-5213 or get in touch with your nearest Vickers Aircraft Application Engineer.

Vickers Airborne Electrical Power Packages

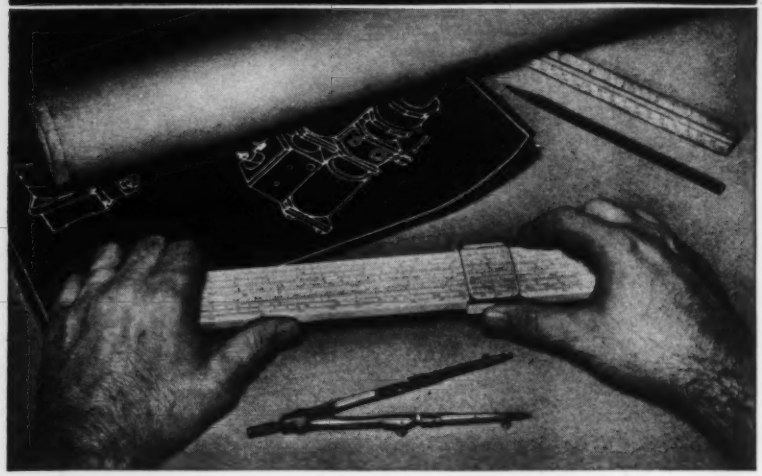
kva output	weight, pounds
0.5	7.0
1.0	10.5
1.5	12.5
2.0	15
2.5	17
3.0	19

Larger capacities with minimum weight are available.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1430 • Detroit 32, Michigan
Aircraft Application Engineering and Service Offices: El Segundo, California, 2160 E. Imperial Highway • Detroit 32, Michigan, 1400 Oakman Blvd. (Service Only) • Arlington, Texas, P. O. Box 213 • Washington 5, D.C., 624-7 Wyatt Bldg. Additional Service facilities at: Miami Springs, Florida, 641 De Soto Drive
TELEGRAMS: Vickers WUX Detroit • TELETYPE "ROY" 1149
CABLE: Videt
OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd. Great West Road, Brentford, Middx., England

Engineers and Builders of Oil Hydraulic Equipment Since 1921

FILTER FORUM



Question:

What facts should a product designer determine before choosing a filter?

Success of any pre-planned filter installation is dependent on calculations which are fundamental to the special field of filter design. As a rule, the data is simple to determine. Where unusual conditions exist, Purolator will design special filters to handle them.

Answer:

These five facts: 1. Degree of filtration, 2. Flow rate, 3. Contamination to be removed, 4. Viscosity of fluid, 5. Provision for cleaning or replacement.

1. Degree of filtration of a filter medium means the size of the smallest particles filtered out with 98% efficiency—expressed in microns for sizes less than .001 inch.

2. Flow rate is the flow that a clean filter unit will handle calculated in terms of the fluid's viscosity and the allowable pressure drop through the filter.

3. Contaminants are any elements from water to dust that shouldn't be there—the materials themselves, their quantity, their size.

4. As a rule, the pressure drop through a filter for a given flow rate is proportional to its viscosity.

5. Provision for cleaning or replacement depends on the predicted effects of a temporary lack of filtration while the cleaning or replacement is accomplished. Can the equipment operate temporarily without filtration, for example, can it be shut down periodically – or will two filters be needed; one for cleaning, one for service.

MAIL COUPON FOR DESIGN INFORMATION

PUROLATOR

FIRST in the field of filtering

Dept. D11-78, Purolator Products, Inc., 970 New Brunswick Ave., Rahway, N. J.

Please send me the following filter information:

_____ Purolator's new "Filtration Manual for Designers". I'm enclosing 25¢ to cover postage and handling.

_____ Enclosed is a description of our filter problem. How should we solve it?

NAME_____ TITLE_____

COMPANY_____ ADDRESS_____

CITY_____ ZONE_____ STATE_____

—ITEM 604—

New Parts

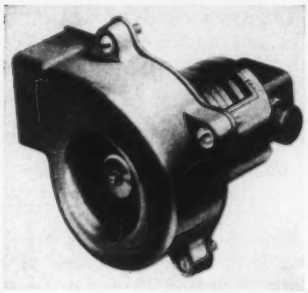
handwheel valves. Optional are quick disconnect valve couplings which permit the valve to be operated directly at the valve handwheel. Special clamps for fastening the flexible shaft, and piercing sleeves for going through floors are available. Core size diameters range from ½ to 1⅝ diam.; torque input ratings are 20 to 250 lb-ft, depending upon diameter. Minimum operating radius runs from 12 to 24 in. **Stow Mfg. Co.**, 11 Shear St., Binghamton, N. Y.

—Circle ITEM 477

Centrifugal Blower

has permanent-magnet motor

Designed for dissipating heat generated by electron tubes, circuit components and similar equipment



mounted in confined enclosures, this permanent-magnet centrifugal blower is available in several sizes with either clockwise or counterclockwise rotation. Motors can be furnished for voltages from 6 to 115 v, dc. Air volume delivered by a typical unit at zero static pressure and 70 F is 20 cfm. **Barber-Colman Co.**, Rockford, Ill.

—Circle ITEM 478

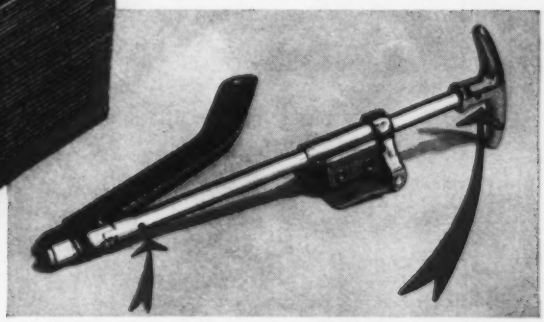
Power Relay

compact unit has interchangeable coils

Compactly designed for limited space application, this 25-amp heavy-duty power relay is suited for switching heavy current or high voltage loads, such as those encountered in motor starting, heaters and heavy-industry control systems. By removing two screws, the relay coil assembly can be removed and replaced by a coil rated from 6 to 230 v ac. No solder

3 Better Methods with ROLLPIN

TO REPLACE A RIVET Rollpin's spring action firmly fastened radio transformer laminations in place and did two things a rivet couldn't do—aligned the laminations and compensated for minor hole variations.

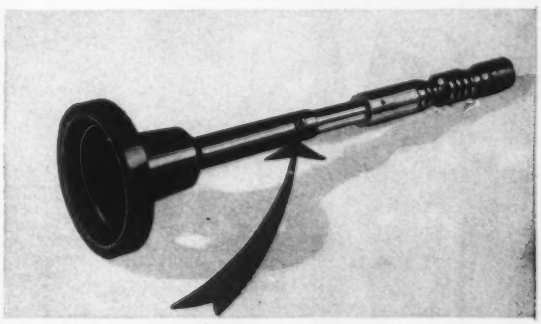


TO REPLACE A STOP PIN Rollpin's self-locking action eliminated staking or peening operations required to retain a straight solid pin.

TO REPLACE A SET SCREW on automobile brake handle, Rollpin is self-retained in the hand grip but can easily be driven into over-drilled hole in shaft to free handle, then removed and used again.

Where can you use this simple fastener?

If you use locating dowels, hinge pins, rivets, set screws —or straight, knurled, tapered or cotter type pins, Rollpin offers the opportunity of a better method that can cut assembly and maintenance costs. This slotted tubular steel pin with chamfered ends eliminates special machining, tapping, and the need for precision tolerances. Driven into a hole drilled to normal production standards, it locks securely in place, yet can readily be drifted out and reused whenever necessary.



TO REPLACE A DRIVING PIN for a flexible drive shaft on a washing machine, Rollpin cut assembly costs by eliminating precision drilling and reaming

MAIL COUPON FOR DESIGN INFORMATION

Elastic Stop Nut Corporation of America
Dept. R37-74, 2330 Vauxhall Road, Union, N. J.

Please send the following free fastener information:

☐ Rollpin samples
☐ Rollpin bulletin
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone____ State____

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

ROLLPIN TRADEMARK

—ITEM 605—

NEW! low-price Fast's Coupling

. . . for light and medium drives!

It's the new MODEL B—lighter, smaller, with all the famous Fast's features—yet priced at a new *low!* The new MODEL B is designed for light-to-medium drive units such as fans, blowers and pumps—where cost is important. Now these products can afford the rugged construction and trouble-free performance of genuine Fast's Couplings.

All steel, dust and moisture proof with metal seal, the new MODEL B is available for shaft sizes up to 2⅝". Sold with Koppers *free* engineering service!

Find out how the new Fast's MODEL B can solve your coupling problem. Write, wire or phone: KOPPERS COMPANY, INC., Fast's Coupling Dept., 3507 Scott St., Baltimore 3, Maryland.

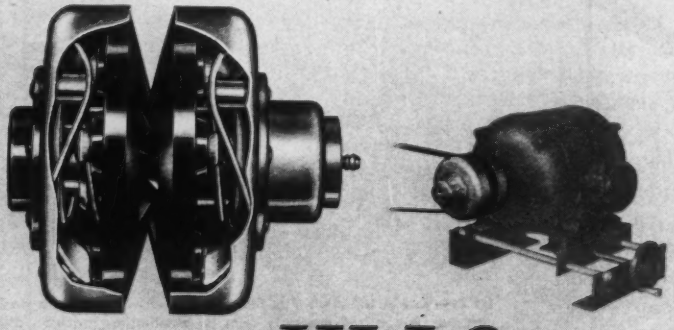
KOPPERS

THE ORIGINAL *FAST'S Couplings*

Engineered Products Sold with Service

—ITEM 606—

striving for SIMPLICITY?



here's how HI-LO *helps*

Design-wise, HI-LO automatic variable speed pulleys help you reduce complex design problems. Functionally, they're first choice of many design engineers for a wide range of applications. The simple, positive action of cam followers on cams is the mechanical action that takes place in maintaining the pitch diameter setting regardless of load—an exclusive feature of HI-LO pulleys. Springs in HI-LO pulleys are not driving members as in most spring-loaded pulleys, but serve primarily to keep the pulley faces in contact with the belt.

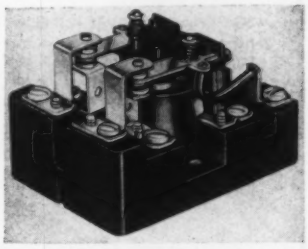
For *FREE* technical manuals with diagrams, descriptions of applications and other power transmission data, write:

Equipment Engineering Company

2855 Columbus Ave., Minneapolis, Minnesota

—ITEM 607—

New Parts



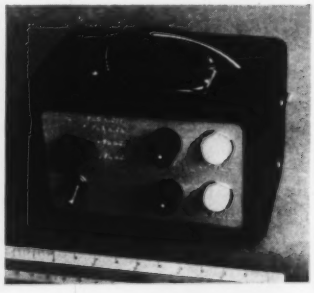
connections are required when coils are changed. Contacts are heavy-duty type, rated at 25 amp continuous duty at 230 v ac with a 75 per cent power factor load. Standard unit is double pole, double throw. Relay measures 3⅜ x 2½ x 2 3/16 in.; weight is 11 oz. **Guardian Electric Mfg. Co.**, 1621 W. Walnut St., Chicago 12, Ill.

—Circle ITEM 479

Miniature Controller

actuated by photo-electric or proximity detectors

Up to 500 w of power can be controlled by model 6140 miniature controller. A self-contained rotary switch allows rapid selection of any of four output functions: Power normally-on or normally-off, and switching normally-open or normally-closed. Convenience plug outlet is provided for connection to the controlled device. For use as input sources to the

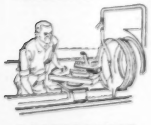


controller, a variety of pickups can be supplied. Model 6130 photo-electric detector, an ultra-miniature element of high sensitivity and rugged construction, is designed to be contained within its miniature aircraft-type connector. Model 6120 proximity detector probe is capable of detecting the presence of all metallic and certain non-metallic articles near its

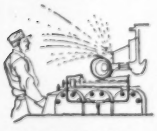
ARE RINGS YOUR PROBLEM?

then HELP YOURSELF

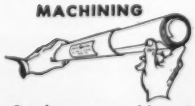
WELDING



FABRICATING



MACHINING



Send us your blueprints and we will show you how we can fit into your picture.

to a quarter of a million square feet equipped to solve your problem

American Welding has a quarter of a million square feet of floor space that houses the equipment necessary to manufacture production runs of welded rings (made from rectangular bars or special mill shapes) or circular weldments — from 6″ to 96″ in diameter, of ferrous or non-ferrous metal.

And that's not all — 900 specialists in ring manufacture are backed with the best in engineering and research — with heat treating, x-ray and test equipment required to meet aircraft specifications.

Let Amweld become your production welded ring department.

THE AMERICAN WELDING & MANUFACTURING CO.
130 DIETZ ROAD • WARREN, OHIO

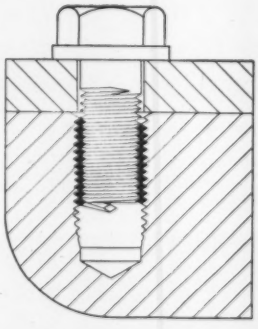
AMERICAN WELDING

—ITEM 608—
For More Information Circle Item Number on Yellow Card—page 19

STRONGER CLEANER LIFETIME THREADS

in lighter, softer, thinner materials

with HELI-COIL* Screw Thread Inserts



Heli-Coil Inserts, coils of stainless steel or phosphor bronze wire, produce superior internal threads that solve many design problems. Thousands of manufacturers are using them to greatly increase thread strength in light metals, wood, plastics. In ferrous metals they are widely used to stop corrosion, seizing, and galling. They increase thread life. In thousands of applications *Heli-Coil* Inserts now enable designers to use thinner materials, shorter thread engagements, lighter materials—to save space, time and money.

Send in the coupon today. You'll get samples and complete information.

***Heli-Coil* Inserts conform to official Military Standards MS122116-122275(ASG), MS124651-124850(ASG) & MS33537(ASG)**

*Reg. U. S. Pat. Off.

HELI-COIL CORPORATION
12/ Shelter Rock Lane, Danbury, Conn.

- ☐ Send samples and Design Manual 652A.
- ☐ Send samples and Military Standards Manual 689A.
- ☐ Please have a *Heli-Coil* Thread Engineer call.

NAME_____TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ZONE____STATE_____ 3052

IN CANADA: W. R. WATKINS CO. LTD., 41 Kipling Ave. S., Toronto 18, Ont.

—ITEM 609—

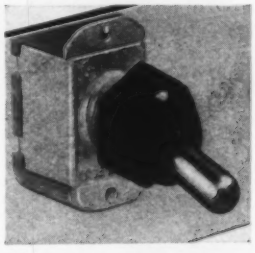
New Parts

detection face. The controller can also be used where extremely low forces are available for actuating contact switches of the low current capacity type. **Autron Engineering Inc.**, 1254 W. Sixth St., Los Angeles 17, Calif.

—Circle ITEM 480

Toggle-Switch Boots

withstand temperatures from −125 to 500 F



N-1030B prelubricated toggle-switch boots are designed for standard toggle-switches in accordance with MIL-S-3950, JAN-S-23 and MIL-S-6745. They also meet requirements of military standards MS24371 and MIL-B-5423. Constructed with an integral hex nut, they can be tightened with ordinary pliers. They have one-piece construction of silicone rubber and withstand temperature variations from −125 to 500 F. The boots are unaffected by salt water, acids or ozone. Double O-ring construction formed in the neck of the boot provides firm sealing against the bat handle of the switch, and effective panel sealing is obtained by a gasket rib formed in the base of the holding hex nut. **Automatic & Precision Mfg. Co.**, 252 Hawthorne Ave., Yonkers, N. Y.

—Circle ITEM 481

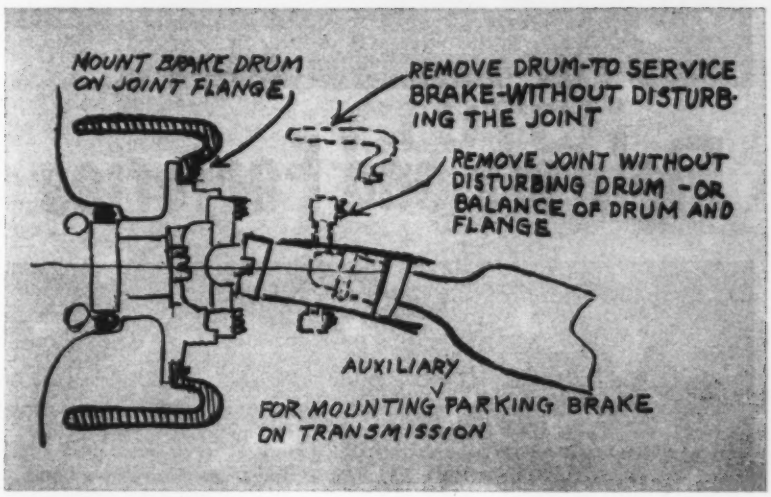
Roller Chain

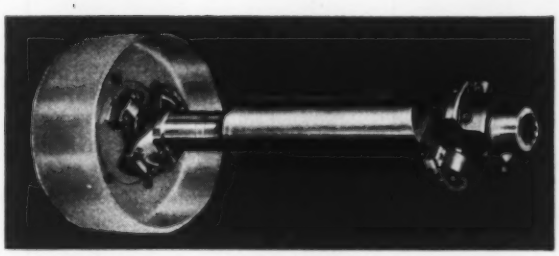
is stainproof and corrosion-resistant

This electrolized roller chain meets requirements of many industries where corrosion resistance is an important factor. Made in all standard American roller chain sizes, it surpasses all accepted specification standards for these chains. It is stainproof and corrosion-resistant, and has high

Prevent Run-Away Trucks— THIS EASY WAY

Truck manufacturers found that serious accidents, caused by run-away trucks, can be prevented by improving the auxiliary parking brake on the transmission. The problem was to mount the brake drum on the universal joint flange. MECHANICS engineers studied and solved the problem — as shown in the sketch at the right.


MOUNT BRAKE DRUM ON JOINT FLANGE
REMOVE DRUM-TO SERVICE BRAKE-WITHOUT DISTURBING THE JOINT
REMOVE JOINT WITHOUT DISTURBING DRUM -OR BALANCE OF DRUM AND FLANGE
AUXILIARY PARKING BRAKE FOR MOUNTING ON TRANSMISSION



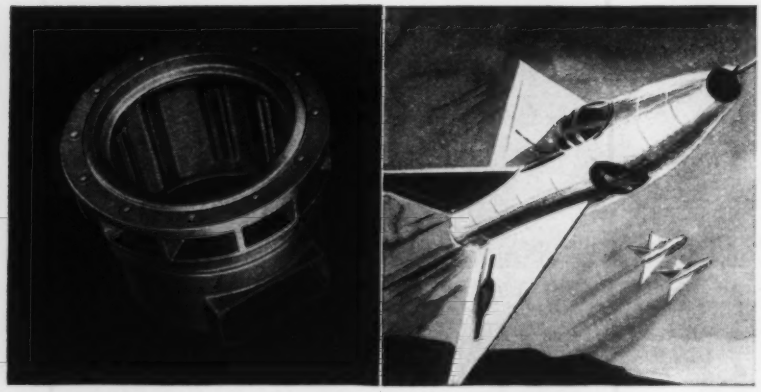
Note that the brake drum is mounted directly on the flange of the universal joint. Also note that the brake drum can be removed for servicing the brake without disturbing the universal joint — and the joint can be removed without disturbing drum or the balance of the flange or drum.

If you have a transmission *mounting, space, torque, balance* or *other* problem — you are invited to utilize the extensive experience of MECHANICS universal joint engineers.

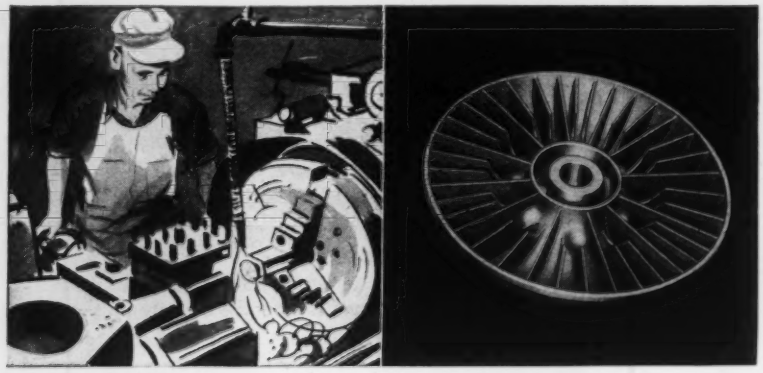
MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2032 Harrison Ave., Rockford, Ill.
Export Sales: Borg-Warner International
79 E. Adams, Chicago 3, Illinois

MECHANICS
Roller Bearing B-W
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment



Fighters and Factories



Thompson Light Metal Castings and Impact Extrusions Serve All Industry

THE machinist turning out production parts and the pilot flying the speedy jet fighter have one thing in common—both *can count on Thompson.* The factory worker's machine and the pilot's jet engine are each improved by precision-engineered castings produced by Thompson's versatile Light Metals Division.

In the case of the fighter, it's any one of several parts including the alternator housing or an air connector used for cooling electric generators that's produced by Thompson—with the factory machine, one of the parts manufactured by Thompson is the casting for the fluid clutch.

These are but two of the many light, strong, durable castings designed, developed and manufactured by Thompson for a diversified list of customer uses. Today Thompson is producing light metal castings for such products as buses and garbage disposers; washing machines and jet planes; automobiles and industrial engines; ice scoops and aircraft engines.

Regardless of your product, if you use castings or impact extrusions, Thompson's creative engineers will gladly show you where and how you can simplify your operations and save on costs with Thompson Light Metals Castings.

We want to quote on your plans and specifications. Write, wire or phone Dept. MD-7, Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio, HEnderson 1-6765.

You can count on

Thompson Products

LIGHT METALS DIVISION

2269 Ashland Rd. • Cleveland 3, Ohio

—ITEM 611—

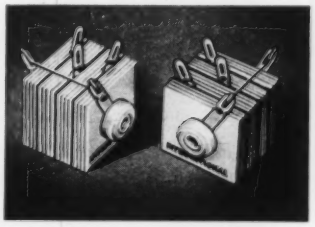
New Parts

tensile strength. Electrolizing produces a smooth surface which lessens the coefficient of friction and cuts wear. The chain resists the action of corrosives, such as acetic acid, bleaching powder, citric acid, hydrogen peroxide, salt and salt spray, nitric acid and sulfuric acid. **Atlas Chain and Mfg. Co.,** Dept. E, West Pittston, Pa.

—Circle ITEM 482

Selenium Rectifier

compact unit has high output



For application with solenoids, counters, relays, variable-speed controls and dc motor field supplies, these compact and inexpensive selenium rectifiers deliver 90 v dc at 175 ma with 130 v maximum rms input voltage. Type 61-2020 rectifier is a single-phase full-wave unit measuring 1 x 1 13/32 x 1¼ in. **International Rectifier Corp.,** 1521 E. Grand Ave., El Segundo, Calif.

—Circle ITEM 483

Nitrile Rubber

is resistant to discoloration

This light-colored nitrile rubber, designated Chemigum N6B, is an oil-resistant rubber for use in applications where color or nonstaining properties are important, such as in flooring and clear cements. It also has application where resistance to ultra-violet light of photo-chemical degradation is needed. The material shows the same processing characteristics and physical properties as standard Chemigum N6; use of an improved antitoxidant system provides the additional nonstaining and nondiscoloring characteristics. **Goodyear Tire & Rubber Co., Chemical Div.,** Akron 16, O.

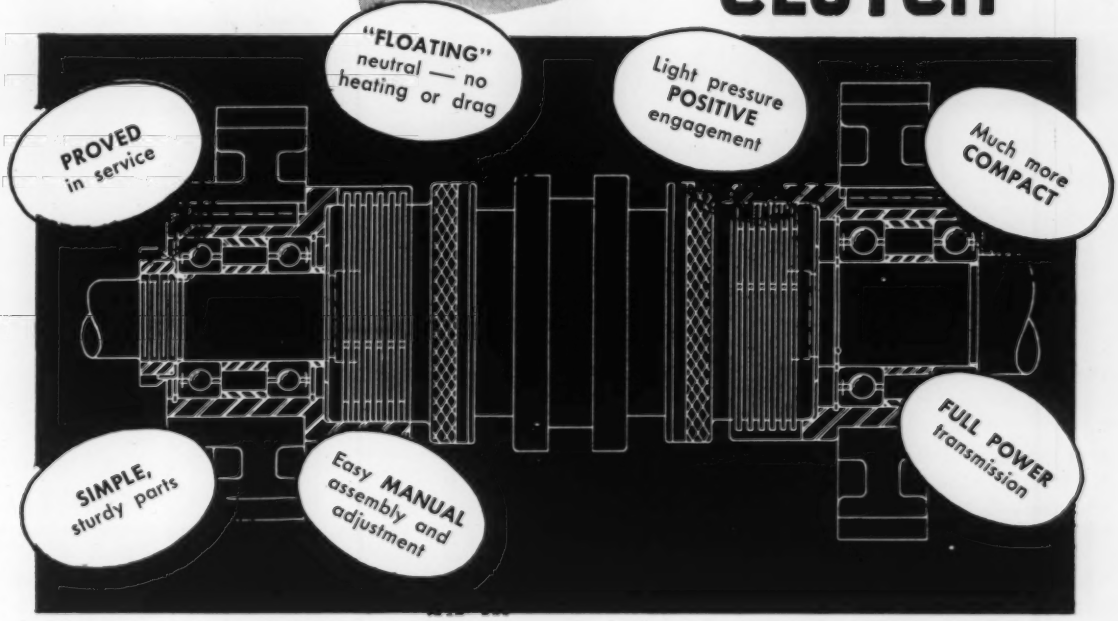
—Circle ITEM 484

BUILD INTO YOUR PRODUCT THE TROUBLE-FREE PERFORMANCE OF A

MAXITORQ

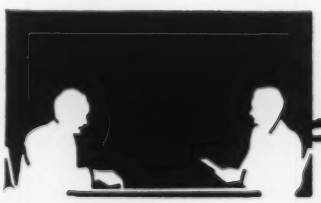
floating disc

CLUTCH


"FLOATING" neutral — no heating or drag
Light pressure POSITIVE engagement
PROVED in service
Much more COMPACT
FULL POWER transmission
Easy MANUAL assembly and adjustment
SIMPLE, sturdy parts

Here is an example of the simple, rugged, and compact installation possible with a MAXITORQ Double Clutch, with pulley-type driving cups, as the speed-change control between high and low-speed gears. Since MAXITORQ clutches, because of their exclusive design features, are always quick and positive in action while at the same time completely free in neutral, this type of installation has a well-proved record of performance to recommend it.

Other types of MAXITORQ Floating Disc Clutches . . . single, double, and overload release . . . are available in a wide range of stock sizes to meet the needs of a great many installations. Our engineering department also stands ready to help you with special drive problems. Write or phone Dept. MD-7. The Carlyle Johnson Machine Company, Manchester, Conn.

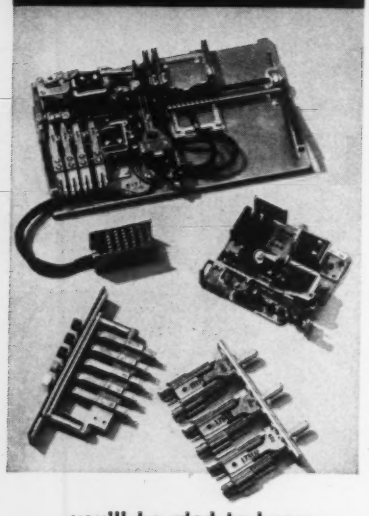


Let's talk **MAXITORQ**

7CJ55

WHEN YOU NEED

Switches and Keys...



. . . you'll be glad to know that expanded production at

STROMBERG-CARLSON

now makes available to you the top-rated products formerly distributed only to the Independent telephone industry.

This announcement promises the two most important things in your supply problem—*quality* in the products and *no priority* in orders for these hard-to-get items.

The 62-year reputation of Stromberg-Carlson is your guaranty of excellence. And our booming expansion program lets us offer production to industries we could not supply in years past.

START *with a look at our new catalog—sent on request. Or, if you have an immediate and specific problem, write to the address below and we'll suggest a solution.*

S-C STROMBERG-CARLSON

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

TELEPHONE INDUSTRIAL SALES

118 CARLSON ROAD, ROCHESTER 3, N. Y.

—ITEM 613—

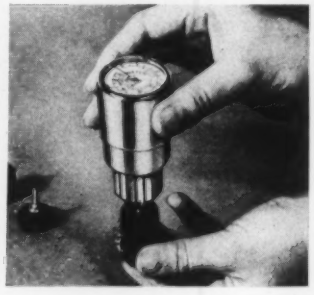
ENGINEERING DEPARTMENT

EQUIPMENT

Torque Gage

watch-sized instrument is accurate to 5 per cent

Model 6500 Torque-Watch gage measures torque in either clockwise or counterclockwise directions. Instrument face is 1 in. diam and has two linear scales in different colors spread over 300



deg. Standard ranges are 0.1 to 1.2 oz-in. and 1.0 to 20 oz-in.; special ranges are also available. Weighing 7 oz and measuring 1⅛ in. diam, 3 7/16 in. long, the gage has an accuracy of ±5 per cent of full scale. Jacobs chuck supplied fits all shafts up to ¼-in. diam; ¼ or ½-in. key chucks are also available. **Waters Mfg. Inc.,** P.O. Box 368, South Sudbury, Mass.

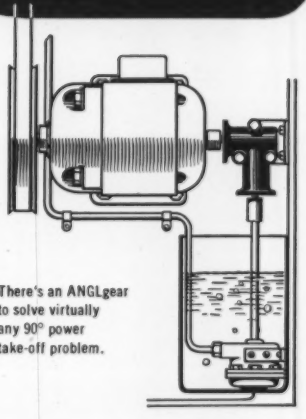
—Circle ITEM 485

Load-Cell

has natural frequency of 1900 cps

Designed to measure extremely high-frequency variations of thrust, such as those imparted by explosive reactions of solid-propellant rockets, this SR-4 force transducer, with 20,000 lb capacity, has a 1900 cps natural mechanical frequency response—more than twice that of similar type load cells. To ensure maximum rate of thrust transmission to the gages, the two bases of the load cells are made of tungsten carbide, which reduces

ANGLgear takes power around corners neatly!



There's an ANGLgear to solve virtually any 90° power take-off problem.

Simple, compact, permanent—that's ANGLgear, the standardized right-angle drive. ANGLgear is versatile; can be mounted four different ways; thus is easy to design into your power transmission system. ANGLgear has high capacity: Model 340, rated 3 hp at 1200 rpm, will transmit a torque of 2500 lb. in. ANGLgear is sturdy; has tough Coniflex* gears, antifriction bearings, and is lubricated for life.

ANGLgear comes in 1/3, 1 and 3 hp sizes, with 1-1 or 2-1 gear ratios and 2- or 3-way shaft extensions.

Next time, specify ANGLgear in place of costly or unwieldy custom-made drives. See our literature in Sweet's product design file; then contact your local distributor or write us for information.

*TM The Gleason Works, Rochester, N.Y.

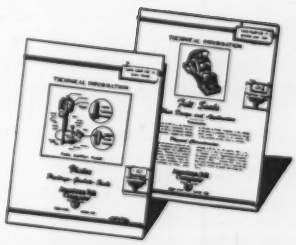
AIRBORNE

AIRBORNE ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY

—ITEM 614—

The seals shown here are a combination of felt for shaft lubrication, plus spring-loaded leather or rubber for exclusion of water, fumes, dust. Such seals are made by a number of companies, in standard and special diameters. List of firms on request. Felt seals can also be made impervious by metal enclosures, or by the use of felt with one or more laminations of synthetic rubber. Just remember that felt is so versatile that it can either lubricate or seal, or both at the same time. On request we will collaborate on designs and specifications. Write for Data Sheet No. 11, "Felt Seals, Their Design and Application," and for No. 14, "Vistex, Packings, Gaskets, Seals."



American Felt Company
TRADE MARK ®

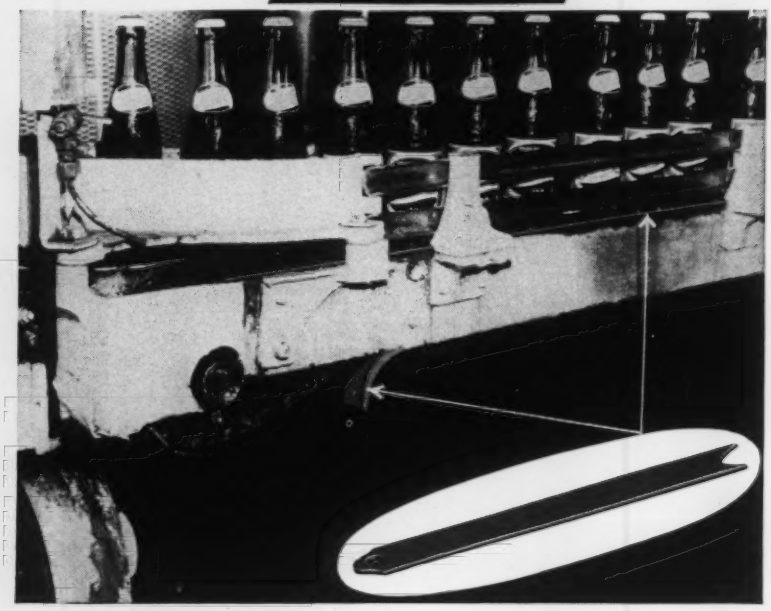
GENERAL OFFICES: 22 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Greenville, S. C., Dallas, San Francisco, Los Angeles, Portland, San Diego, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

FREE! Write for Data Sheets Nos. 11 and 14.

—ITEM 615—

POLYPENCO® NYLON SHAPES



NYLATRON® GS Wear Strips . . .
Provide Quiet Operation, Eliminate Costly Downtime

A bottling company, forced to shut down twice a year to repair and rebuild the channel in their conveyor stand, turned to POLYPENCO Nylon. NYLATRON® GS wear strips made from specially compounded nylon were installed between the frame and the chain to eliminate metal-to-metal contact. After nearly a year, there is no noticeable wear on either nylon or metal surfaces, operation is smoother and quieter.

POLYPENCO Nylon is an established material for engineering and design . . . here's why:

POLYPENCO Nylon's wear resistance, low surface friction and other properties provide longer wear, less downtime, fewer repairs.

POLYPENCO Nylon is available in strip, rod, tubular bar, slab, flexible tubing and hexagonal bar for rapid, low cost machining on standard metalworking tools.

NYLATRON GS, a molybdenum disulphide-filled nylon† is a special formulation designed to expand the field for nylon in providing parts with *lower surface friction, lower thermal expansion,* higher heat distortion temperatures and superior wear resistance in many cases. *†Patents Applied For*

THE POLYMER CORPORATION OF PENNA. • Reading, Penna.
In Canada: Polypenco, Inc., 2052 St. Catherine St. W., Montreal, P.Q.

POLYPENCO Nylon, Teflon*, Q-200.5 and K-51

*DU PONT TRADEMARK

—ITEM 616—
For More Information Circle Item Number on Yellow Card—page 19

Engineering Equipment

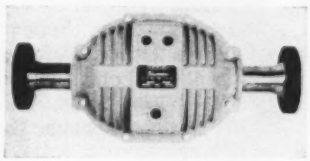
deflection to one-third that of steel. Use of two independent strain gage bridge circuits permit two independent records of thrust to be produced. One circuit is used with an oscillograph to measure the peak transient thrust that occurs during the first few milliseconds of thrust application. The other bridge circuit is wired to permit the higher input voltages and consequent higher output voltage necessary to record comparatively long term, low level thrust that may be only one-tenth that of the peak value. **Baldwin-Lima-Hamilton Corp.,** Electronics & Instrumentation Div., 806 Massachusetts Ave., Cambridge 39, Mass.

—Circle ITEM 486

Magnetic Flow Meter

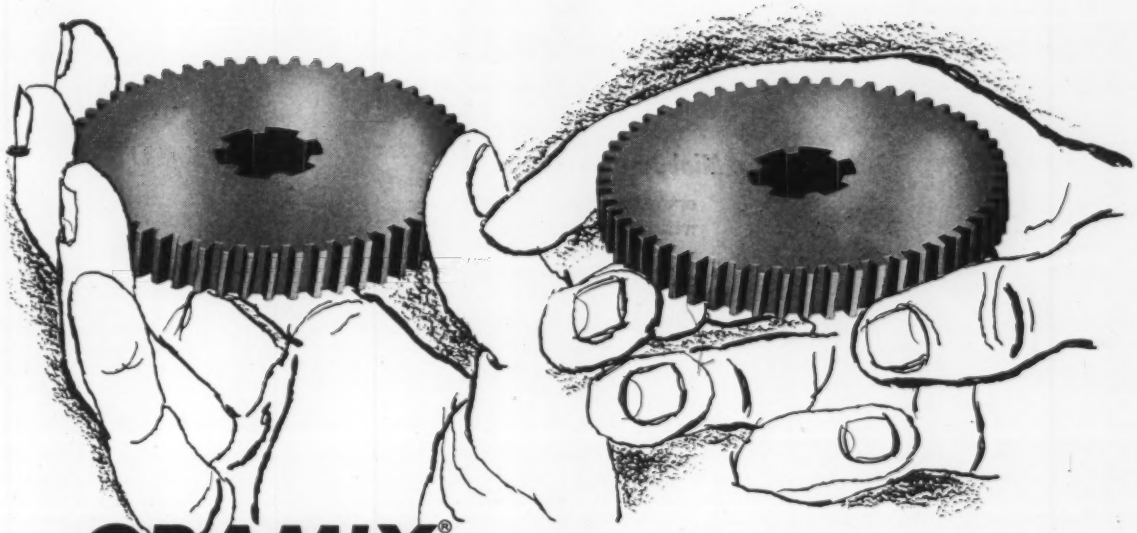
unaffected by changes in density, viscosity or pressure

Now available for 1-in. flow lines, this magnetic flow meter measures fluid flows to an accuracy of ±1 per cent of full scale. It introduces no restriction to the flow, provides linear flow records and is unaffected by variations in pressure, viscosity, or density or changes in conductivity of the flowing liquid. Principal components are a Teflon

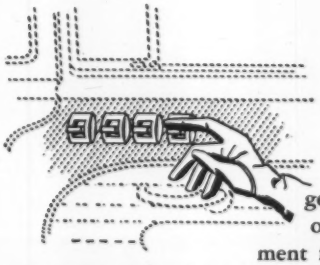


insulated flow tube, flush-mounted metallic electrodes and an ac electromagnet. When conducting liquid passes through the tube, an ac voltage varying linearly in proportion to the flow rate is set up between the electrodes. Lead wires from the electrodes transmit this voltage output to a recorder, producing a chart record in appropri-

which helical gear costs 80% less?



the GRAMIX® sintered metal helical gear performs better than a forged and hobbed aluminum part for just 1/5 the cost!



By replacing forged aluminum gears with sintered steel GRAMIX helical gears, a manufacturer of automotive equipment found that he could realize an 80% saving and get greater dependability. The gear is a component of an automatic window raising and lowering mechanism currently being used by four different automobile manufacturers. The helical teeth are formed in the compacting dies, and, after sintering, the GRAMIX gear is ready for assembly into the power window unit . . . there is no need for costly machining or time-consuming finishing operations like the hobbed aluminum gear used previously. In spite of the astonishing savings, these GRAMIX gears have proven to be even better than the former forged gear from a standpoint of toughness and wearability.

GRAMIX metallurgists can provide the exact alloy for your design specifications. GRAMIX parts may be oil-impregnated for self-lubrication. They seldom need machining, and will often outlast similar machined parts. Complex shapes can be produced to tolerances as close as .0005". Whatever your requirements may be, it will pay you to investigate GRAMIX.

Do you have our big detailed GRAMIX catalog? . . . write today for your copy.

114

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

—ITEM 617—

with Promet Engineered Bronze

BEARINGS · BUSHINGS
WEARING PARTS

—just as you are also guaranteed superior service or your money back.

DIFFICULT OIL GROOVING

. . . smooth grooves, even around acute bends . . . no sharp edges or burrs . . . improved lubrication because there is no "wiping" action. Available rough cast if desired.

SEND PRINTS

and condition of operation for recommendations, quotations, literature and service data sheets.

The American Crucible PRODUCTS CO.

"Bearing Specialists Since 1919"

1321 OBERLIN AVENUE, LORAIN, OHIO, U.S.A.

Please send free literature and service data sheets on Promet Bronze.

NAME_____

COMPANY_____

STREET_____

CITY & STATE_____

—ITEM 618—

Engineering Equipment

ate flow units. Capacity of the 1-in. meter is 10 gpm or greater. Flow tube is schedule 10 pipe (304 stainless steel) and end connections are 150-lb or 300-lb plain-face flanges. **Foxboro Co.**, Foxboro, Mass.

—Circle ITEM 487

Miniature Pressure Pickup

operates at 600 F temperature without air or liquid cooling

Type 4-316 pressure pickup, which more than doubles the usual temperature range for this type transducer, operates continuously without cooling at temperatures to 600 F. Supplied in both gage and differential pressure types, it consists of unbonded strain gage windings connected in a four-arm bridge. Pressure on the diaphragm displaces sensing elements and changes the resistance of the bridge active arms. Output is proportional to applied pressure. Effects of acceleration and vibration are cancelled by geometry and winding arrangement of the star-spring sensing elements. The unit is ½-in. diam, ¾-in. long, and weighs 15 gm with its 30-in. insulated four-conductor cable. **Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif.

—Circle ITEM 488

Recording Thermometer

measures and records temperature extremes

This recording maximum-minimum thermometer measures the ambient temperature and records both the highest and lowest extremes over any given period of time. Model 581-F has temperature range from −50 F to 250 F; model 581-C has −50 to 100 C range. Paper chart on which temperature excursions are recorded is easily replaced. Typical uses include the evaluation of performance of heating and air-conditioning systems and the recording of total excursion of temperatures in low-temperature ovens and similar enclosures. **Pacific Transducer Corp.**, 11836 W. Pico Blvd., Los Angeles 64, Calif.

—Circle ITEM 489

You Wouldn't Buy A Coat That's Too Big! So Why Buy A Control That's The Wrong Size!

FURNAS MAGNETIC CONTROLS GIVE YOU CORRECT CAPACITY FOR THE JOB!

The many in-between sizes in the Furnas Electric starter line let you select the motor control that is best suited for your particular requirements—with no wasted capacity and expense. Match the starter to the job and save up to 25%. For proof, compare the 10 sizes of the Furnas Electric starter line with the 5 sizes normally offered. And you can save up to 40% in space by using the correct size starter.

For more information write for Bulletin 5530 — 1045 McKee Street, Batavia, Ill.

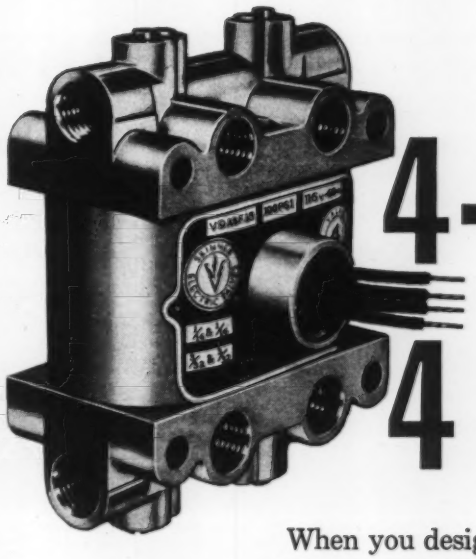
A5

FURNAS ELECTRIC COMPANY

BATAVIA, ILLINOIS

Sales Representatives in all principal cities

—ITEM 619—



4-WAY for 4 REASONS

When you design or modernize equipment, look into the four big reasons for using Skinner's low-cost V9 Solenoid Valve. 1. Only 4 5/10″ high, the V9 fits nearly anywhere, saves space, yet is powerful enough to operate single- and double-acting cylinders. 2. Available in more than 176 variations of capacities, metering and types; it can be used with air, inert gases, hydraulic oils and other common media at 0-150 p.s.i. 3. The V9 provides leakproof, dependable, *fast* operation — up to 600 cycles per minute in many applications. 4. Its rugged, frictionless construction and precision engineering ensure life spans of *millions of cycles,* eliminating replacement and maintenance problems.

For complete information, write for Catalog D2.

SKINNER

SKINNER ELECTRIC VALVE DIVISION • SKINNER CHUCK COMPANY

THE CREST OF QUALITY

SKINNER ELECTRIC VALVES®

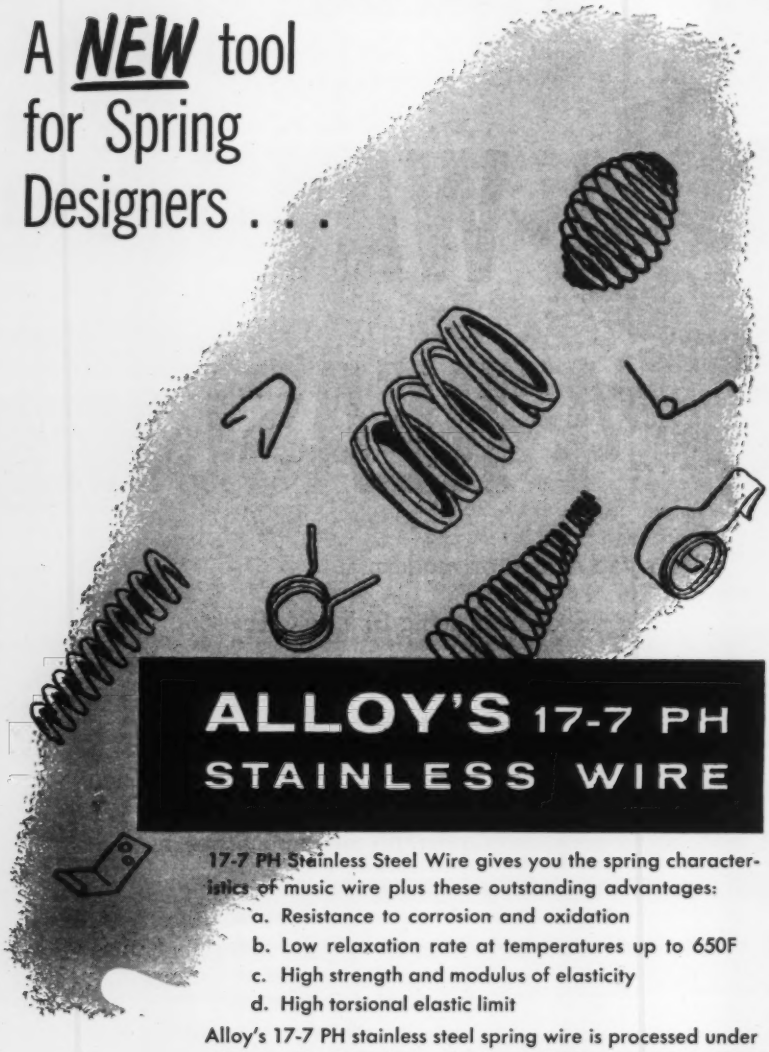
SOLENOID VALVES

115 Edgewood Avenue
New Britain, Conn.

WORLD-WIDE REPRESENTATION

—ITEM 620—

A *NEW* tool for Spring Designers . . .



ALLOY'S 17-7 PH STAINLESS WIRE

17-7 PH Stainless Steel Wire gives you the spring characteristics of music wire plus these outstanding advantages:

a. Resistance to corrosion and oxidation
b. Low relaxation rate at temperatures up to 650F
c. High strength and modulus of elasticity
d. High torsional elastic limit

Alloy's 17-7 PH stainless steel spring wire is processed under rigid quality control standards to obtain optimum properties for spring fabrication. Full mechanical properties of the spring are developed by a single precipitation hardening heat treatment at 900F after fabrication. Because of its excellent dimensional stability, spring dimensions are unaffected by this heat treatment.

We can supply you with 17-7 PH wire in a wide range of sizes in coils or spools. Also available in rod and strip.

For complete information on properties, specifications and heat treatment techniques for Alloy's 17-7 PH stainless steel send for your copy of Technical Bulletin, T-1.

17-7 PH is a registered trade-mark of Armco Steel Corporation

ALLOY HKP

ALLOY METAL WIRE DIVISION

H. K. PORTER COMPANY, INC.
Prospect Park, Pennsylvania

Stress Relief

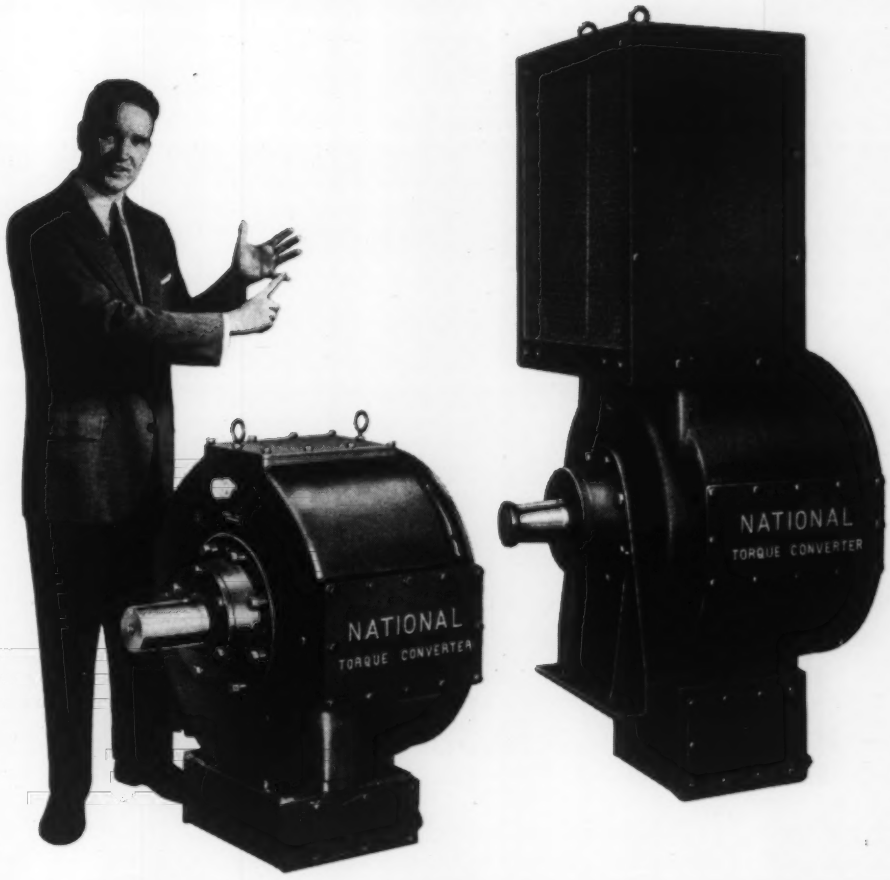
VALENTINE'S DAY, last, D. M. Kobrin of Raytheon's microwave and power-tube operations in Waltham, Mass., wrote to us, asking "Would you like a 21-year old stenographer's views on engineers?" Influenced by the sentiment of the day and with a small spark of hope in behalf of both engineers and engineering editors, we allowed as how we would. Here is Lorraine Dutile's answer to the question,

What Is an Engineer?

An engineer is a person totally dedicated to applied science, production, and his wife—in that order. Like the poet, his primary concerns are those of time and meter. His terminology may and usually does include such prosaic words as modulator, Kovar, voltage, oscillation, and some words not found in the dictionary.

Engineers come in assorted kinds and sizes. First, we have the young bow-tied type (just graduated from Northeastern magna cum lousy) who believes

with all his heart that there should be more unison and less formality between himself, other engineers, and secretaries. Our second type of engineer is kind of a choleric mastermind (generally middle-aged) whose only goal in life is



you get all these features with a National Torque Converter

Now, with National Torque Converters, you can give your equipment smoother power, steadier power over a wider range of loads . . . with exact matching of torque converter to engines of 100 to 1000 horsepower . . . plus *all* these features:

Unsurpassed durability: The rugged design and construction of National Torque Converters provide longer service life with minimum maintenance.

Simplicity of design of National Torque Converters permits ease of installation, operation and maintenance.

Reproducible efficiency of each size and capacity of National Torque Converters permits standardization on your equipment with assurance of uniform top performance on every job.

Top performance: Precision fabrication of National Torque Converters of parts made to close tolerances provides uniformly smooth transmission of power hydraulically from engine to job or load, enabling engine to operate at its optimum speed and thus, to deliver maximum horsepower as required . . . and without ever stalling the engine.

Faster job cycles: Quicker starting and faster acceleration of load with a National Torque Converter in the power system means more work per equipment per operator per day . . . every day.

Full range of circuit sizes: You have a choice of 6 basic hydraulic circuit sizes, each with a range of input ratings, to permit exact matching of torque converter to specific power-speed characteristics of a prime mover.

Why not let a National engineer make specific recommendations of the correct size and capacity of National Torque Converter for your equipment.

THE NATIONAL SUPPLY COMPANY

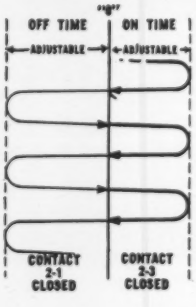
INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center, Pittsburgh 22, Pa.

Pace-setters in the progress of industrial power transmission

EAGLE FLEXOPULSE
repeat cycle timer
WITH S.P.D.T. SWITCH

No gear change or resetting of cams required



This Flexopulse Repeat Cycle Timer is ideal for controlling processing machines requiring adjustable timed cycles. The "on" or "off" intervals are easily adjusted. Either can be adjusted without disturbing the setting of the other. Instead of resetting cams or changing gears, simply loosen two knurled nuts. Then set "on" and "off" periods by moving adjustable pointer. Tighten screws, and the job's done.

HAS CYCLE PROGRESS INDICATION:
A movable flag indicator passing over the time scale between adjustable arms, indicates portion of cycle elapsed in either of the s.p.d.t. positions. Switching operation takes place at zero.
Flexopulse is ideal for periodically operating valves to reverse the flow of liquids, for operating signals or for injecting chemicals. 120-second up to 20-hour dials are available. Synchronous motor powered. Send coupon today for free Bulletin 320.

FREE BULLETIN, MAIL COUPON

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. MD-756
MOLINE, ILLINOIS

Please send free Bulletin 320 with full data on Flexopulse Repeat Cycle Timer.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

—ITEM 623—

Stress Relief

visualized in terms of steel, symmetry, and swiftness. And, of course, there is the soft-spoken, gentle kind whose years of experience have made him the real, but humble, genius.

Engineers are usually found leaning toward an assembly line, discussing electrons near a water cooler, or north of their incoming baskets—stooped over in an attempt to find that last paper clip.

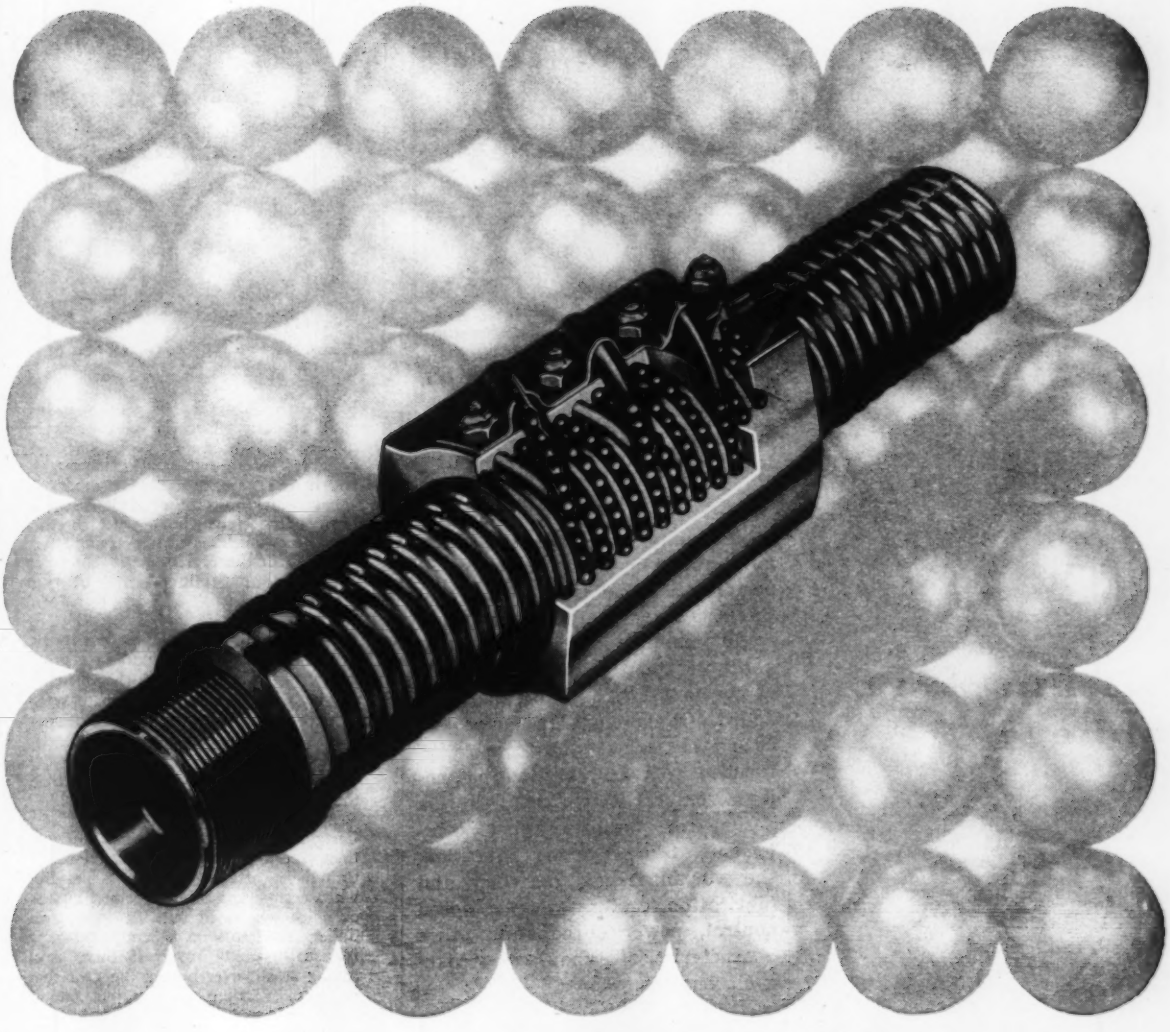
An engineer's morphology is such that he can (to the dismay of his secretary) overlook the most obvious notations and forget the most important meetings. No other phenomenon on earth can equal his capacities to be deaf to the loudest page system, take the longest time to walk from Juechter's office to his own, write the most hieroglyphic memos (rough draft, please), tolerate the most cluttered up drawers, drink the most coffee, dictate the longest letters, and request the most prints from Services.

Certainly no other form of animal life could manage to train a 47 by 32-in. desk to hold a Thermos of coffee, a calendar pad, an incoming and outgoing basket, two rulers, a spotted blotter, an inkwell (sans plume), a nameplate at half-mast, four Spec. books (to be returned at 5:15), an ash tray, somewhere a telephone, assorted parts from distorted tubes, a cartoon from some other frustrated engineer, and a handbook, textbook, and pocketbook on *Transcendental Functions, Industrial Organization,* and *Girls.*

His object is precision; his product is progress; his imagination is his only tool. He is a rationalist with a dream of what could be.

The human in him is evidenced by his casual hello in the hall and his unusual thoughtfulness when you need such. And when you're all but exhausted from tabulated reports, letters, and efforts to page him, the world seems just a little nicer when he says, "How's the boy friend?"

"I respect faith, but doubt is what gets you an education."—WILSON MIZNER



how Vacuum Metals' FERROVAC boosts ball bearing screw life up to 400%...

Ball bearing screw assemblies, first used in automobile steering mechanisms, are now found in such critical applications as the actuation of landing gear and control surfaces of aircraft and guided missiles. And it was in tough jobs like these that the assemblies failed in fatigue. Then a leading manufacturer tried vacuum-melted FERROVAC® for the balls – and service life rose as much as 400% over the original life. Here's why...

Vacuum melting improves fatigue properties – It literally sucks gaseous impurities – focal points for fatigue failure – from the molten metal. Vacuum-melted metals are cleaner, purer, tougher. And cleanliness means an added bonus in fewer rejects.

Only Vacuum Metals gives you one-source service – Vacuum Metal's own large organization, and its affiliation with National Research Corporation and Crucible Steel Company of America, means a fully integrated service from melting and casting through mill rolling and nationwide distribution of finished mill products. And you can get not only small experimental lots, but now, thanks to our new 2500 lb. induction furnace – the nation's largest – you can also get large-scale continuous production quantities of vacuum-melted metals. If you have an application which these unique metals may improve, please write giving full details. *Vacuum Metals Corporation, P. O. Box 977, Syracuse 1, New York.*

VMC

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Jointly owned by Crucible Steel Company of America and National Research Corporation

—ITEM 624—

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within your sphere

when the starting point of your idea is a ball. And Universal makes balls that start you thinking—tolerances under ten millionths of an inch—sizes from pinhead small to golf ball big.

Your idea will go further, faster, smoother when it turns on a ball—and a Universal ball will serve you best at every turn.

Yes, Universal balls make those "impossible" jobs move smoothly—and spark ideas you may have never considered before.

UNIVERSAL QUALITY CONTROL—
FOR ALL AROUND PERFECTION

Universal Ball co.

WILLOW GROVE
MONTGOMERY CO., PA.

—ITEM 625—

THE ENGINEER'S Library

Recent Books

High Speed Combustion Engines, 16th Edition. *By P. M. Heldt;* 805 *pages,* 5½ *by* 8½ *in., clothbound; published by Chilton Co., Chestnut and 56th St., Philadelphia* 39, *Pa.; available from* MACHINE DESIGN, $12.00 *postpaid.*

The 16th revision of this textbook covers the refinements in engines and general improvements in performance that have occurred in the past seven years. A chapter on engine tests has been enlarged and a chapter on the thermodynamics of the combustion engine has been added. Other chapters cover the Otto cycle, conversion from reciprocating to rotary motion, balancing, combustion-chamber design, design of major engine components, bearing loads, vibration, the working media, bearings and lubrication, cooling systems, speed control, power output and other characteristics, and two-stroke-cycle engines.

•

Legal Problems in Engineering. *By Melvin Nord;* 391 *pages,* 6 *by* 9 *in., clothbound; published by John Wiley & Sons Inc.,* 440 *Fourth Ave., New York* 16, *N. Y.; available from* MACHINE DESIGN, $7.50 *postpaid.*

Written by an engineer who is also a practicing lawyer, this book is designed for use and reference by engineers. It should help them avoid legal problems and to work effectively with lawyers should difficulties arise eventually. Subjects covered are: contracts, sales, negotiable instruments, insurance, personal property, real property, torts, workmen's compensation, agency business organizations, municipal corporations, labor law, ethical responsibilities of engineers, professional registration of engineers, construction contracts and specifications, governmental regu-

"Order Me Out a Batch of Gears"

VICE-PRESIDENT, THE CINCINNATI GEAR CO.

How do *you* go about buying gears for your products? Get the best price in order to "save" as much money as possible? Well, economy *is* important, and maybe you can save some money if you consider only the original cost—a few pennies on the price tag of each gear. But how much is this "saving" (if realized) in the *percentage* of the total cost of your product—one or two percent?

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Certainly, in competitive times such as these, it is necessary for any manufacturer to reduce costs wherever possible. But when cost-cutting affects product quality or efficiency, watch out. The saving in dollars and cents on a "cut-price" gear is usually pretty small, if there is a saving at all, over buying the gear that is assuredly "right" for the job. And if your specifications indicate possible use of a custom gear, talk to someone from Cincinnati Gear first and let him point out the advantages of custom gearing, and how good gears can be an economy in the long run. You'll find that putting the major emphasis on getting the *right* gear for the job will pay off handsomely.

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"Gears—Good Gears Only"

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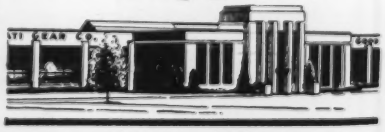

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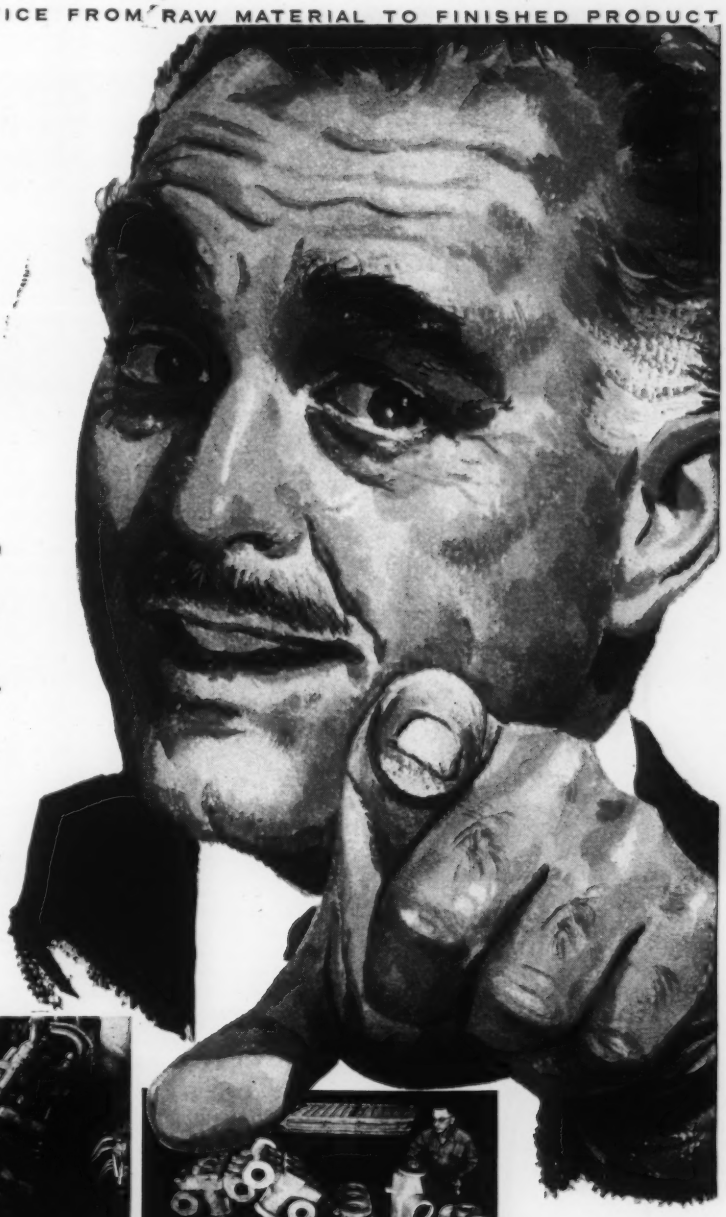


You're the boss when you design with Ampco Alloys

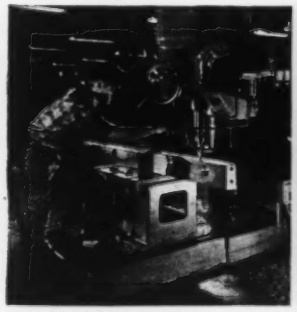
You're not limited to a single copper-base alloy or a single form

Your design behaves the way you want it to, after it takes shape in one of more than 100 Ampco alloys.

Why? Because whether you are looking for resistance to wear, impact, fatigue, or corrosion, Ampco has a tailor-made alloy to meet your requirements.

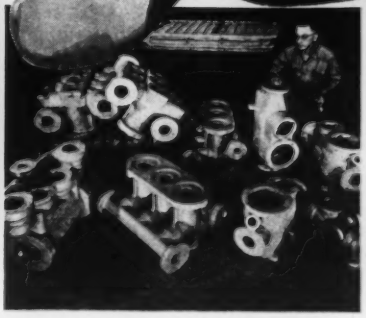
And besides, you have flexibility in selecting the most economical form of production. Why? Because Ampco is available in sand-cast, centrifugally-cast, shell-molded, precision-cast, fabricated, forged, extruded, and sheet and plate forms. A call to your nearby Ampco field engineer will get you an unbiased recommendation.

Write for Bulletin 33 describing the Ampco Metal series of alloys.



Ampco's one-source service includes production-run machining of Ampco copper-base alloys to the quality standards of the aircraft industry.

2,275-ton hydraulic press in Ampco's modern, laboratory-controlled mill for extruding rods, bars, hollow rounds, and shapes.



Motor housings and fluid ends. Ampco produces sand castings like these up to 14,000 pounds — and centrifugal castings up to five tons.

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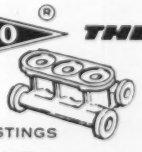

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—ITEM 627—

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The Engineer's Library

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•

Materials Handbook, 8th Edition. *By George S. Brady.* 1018 *pages,* 6 *by* 9 *in., clothbound; published by McGraw-Hill Book Co. Inc.,* 330 *West* 42*nd St., New York* 36, *N. Y.; available from* MACHINE DESIGN, $11.00 *postpaid.*

Subtitled "An encyclopedia for purchasing agents, engineers, executives and foremen," this handbook covers approximately 10,000 materials. The eighth edition has 1000 entries more than the seventh. Special attention has been given to new electronic materials such as semiconductors and heat-resistant materials. Classes of materials are metals, alloys, refractories, abrasives, woods, chemicals, paints and oils. Types of information provided are chief characteristics, comparative data, sources, substitutes, alternates and uses.

Association Publications

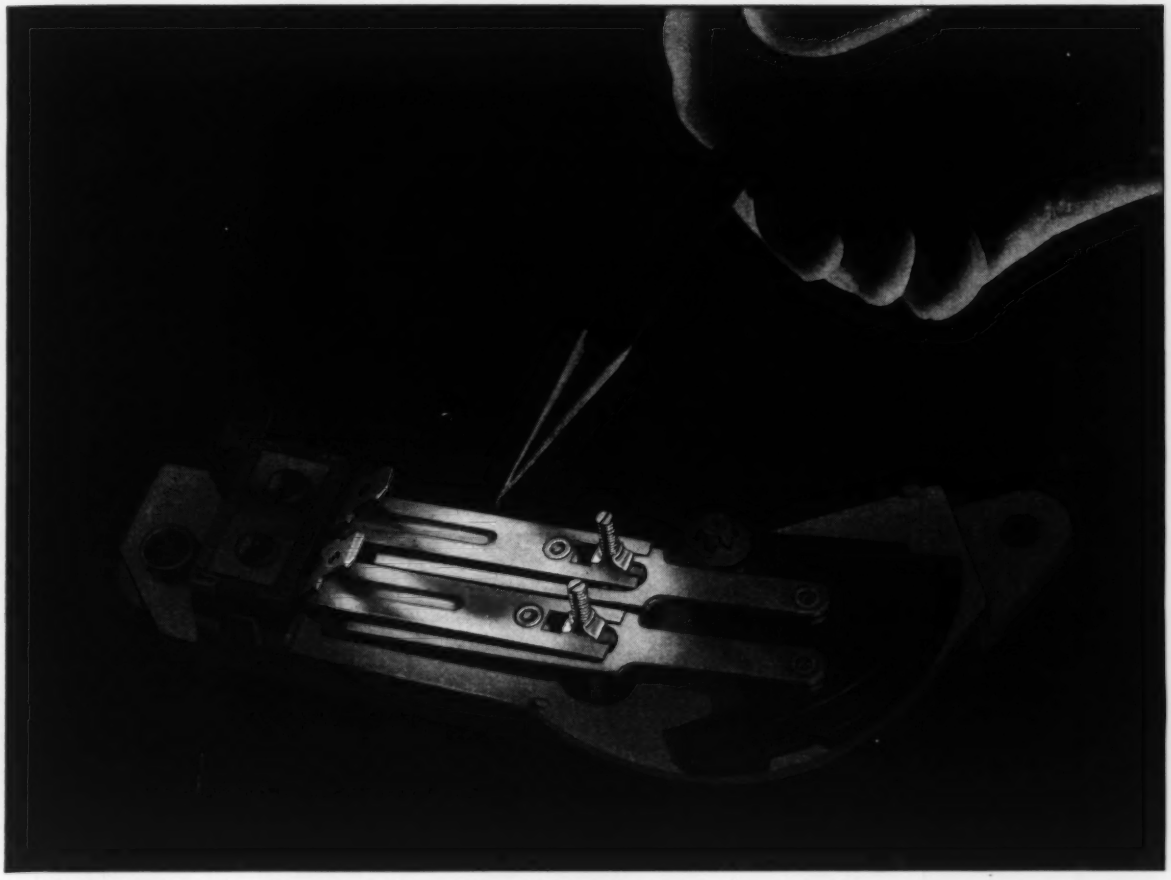
Leather Packings. 57 *pages,* 8½ *by* 11 *in., paperbound; published by and available on company letterhead request from National Industrial Leather Association,* 320 *Broadway, New York* 7, *N. Y.*

Directed to designers and users of hydraulic and pneumatic equipment, this booklet summarizes information to aid in the selection and application of leather packings. It supersedes a less comprehensive edition dated 1947. Major subdivisions in the present edition are: mechanical leather packings; leather for packings; cup, flange, U and vee packings; gaskets, washers and diaphragms; back-up washers and heel pads; surface finish of cylinders and shafts; hydraulic fluids; packing hints; glossary and tables.

•

Proceedings of the Second Annual Computer Applications Symposium. 108 *pages,* 6 *by* 9 *in., paperbound; published by and available from Armour Research Foundation of Illi-*

—ITEM 628—
For More Information Circle Item Number on Yellow Card—page 19



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General Electric's Housewares & Radio Receiver Division, Bridgeport, Connecticut, adopted this one-piece, multiple purpose SPEED CLIP and made profitable savings in the new G-E Automatic Coffee Maker.

Engineered by Tinnerman specially for the thermostat control, each SPEED CLIP replaces three parts—a blade, a bushing, and a lock nut. Controls are now assembled faster, easier, with improved line flow. There are fewer parts to buy, stock and handle... and unit cost has been reduced, too.

Find out about a free Tinnerman Fastening Analysis Survey. It can point the way to more efficient fastening on your assembly line. Get complete information from your Tinnerman representative or write direct for Fastening Analysis Service Bulletin No. 336. There's no obligation.

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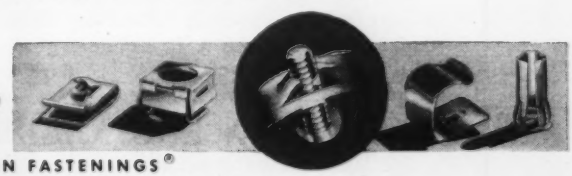
Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN *Speed Nuts*®



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—ITEM 629—

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BALL BEARING
PUSH-PULL
REMOTE CONTROL

provides 97% efficiency with heavy load

- needs no lubrication
- minimizes friction
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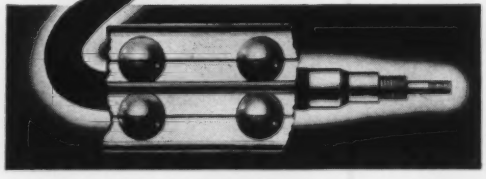
Controlex Remote Control units owe their remarkably efficient operation—97%—to a unique and revolutionary design principle: ball bearings provide friction-free movement of a stainless steel blade in flexible tubing. Permits improved layouts of far greater length and curvature, regardless of load. Requires no lubrication; backlash reduced to a minimum. Precision engineered! Check Controlex before you specify *any* remote control application.



Illustrated folder gives engineering data and full details; write today.

Controlex CORPORATION of AMERICA

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- Long-Lived
- Self-Adjusting

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SPECIFY S-11065 Hydraulic Piston Rod Scraper Ring to assure vital seal reliability and to extend packing life in aircraft and industrial hydraulic and pneumatic equipment. Spring loaded, tough, extremely inert and low in friction they are responsive to rod misalignments, and do not score the rod. Interchangeable with AN6231 Scraper Rings to fit standard groove dimensions of AND10075. Also available in KELON-Y (Nylon). Call your Shamban representative or write direct.

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—ITEM 631—

The Engineer's Library

nois Institute of Technology, Technology Center, Chicago 16, Ill.; $3.00 *per copy.*

This symposium emphasized the applications of computers and data processing machines in two major fields: business and management, engineering and research. In the second group, the subjects of papers include small computer aspects of engineering computations, the use of IBM 650 in scientific computation, engineering applications of large-scale computers, high-speed computation of engine performance, and aircraft test data processing.

Manufacturers' Publications

The Production and Properties of Graphite for Reactors. *By L. M. Currie, V. C. Hamister and H. G. MacPherson;* 61 *pages,* 6 *by* 9 *in., clothbound; published by and available on letterhead request from National Carbon Co.,* 30 *East* 42nd *St., New York* 17, *N. Y.*

This book is a complete printing of a paper presented at the United Nations International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, August 8-20, 1955. Detailed information is presented on the production of artificial graphite in the electric furnace and the effects of raw materials and processing variations. Three chapters are devoted to the physical, mechanical and chemical properties of graphite.

•

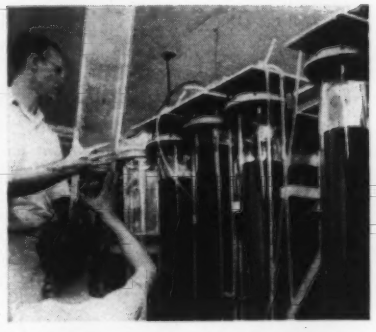
Air Conditioning and Engineering, 2nd Edition. *Edited by the engineering staff of American Blower Corp.;* 260 *pages,* 6 *by* 9 *in., clothbound; published by and available from American Blower Corp., Detroit* 32, *Mich.;* $6.00 *per copy.*

Directed to persons confronted with problems in air conditioning and power transmission, this manual gives fundamental principles, laws and tables, sample calculations and data based on the experience of its several authors. Sections of the book cover air conditioning

CORNING GLASS BULLETIN

FOR PRODUCT DESIGNERS

Gadolinium and all that



Out Chicago way, at Lindsay Chemical Company, they're busy exchanging ions. Purpose? Obtaining commercial quantities of such rare earths as samarium, europium, gadolinium, terbium, dysprosium, erbium, thulium, ytterbium, yttrium, lutetium, and holmium.

At the heart of Lindsay's purposeful and plentiful piping and plumbing, you'll find a number of PYREX brand glass columns.

Glass because it provides complete visual control. PYREX brand glass No. 7740 because (as Lindsay people tell) it provides an absolute minimum (not *minimium*) of contamination and a flexible system that permits ready adjustment.

(Commercial: Chemists are only one breed of practical-minded men who have turned to a PYREX brand glass in one form or another to solve a particularly challenging materials problem.)

Facts: PYREX brand glass No. 7740 is a borosilicate glass having low alkali content and unusual capacity to withstand the ravaging attacks of most acids, and environments like steam under pressure.

This glass also displays a commendable capacity to cope with thermal stress, exhibiting a linear coefficient of expansion of 32.5 x 10^{-7} per °C. between 0° and 300° C.

It's a clear glass and can be handled as blown or pressed ware; also readily made into plates and panels, tubing and rod.

In one product development, even *one-piece molding* of a quite complex shape was profitably accomplished for a manufacturer of dentists' sterilizer trays.

PYREX brand glasses (including a number of interesting variations similar to 7740) offer an unusual challenge to those concerned with the successful and profitable solution of materials problems.

Some hints about the PYREX brand and other glasses by Corning *in use* can be gleaned from Bulletin IZ-1, "Glass . . . its increasing importance in product design." Free with the coupon.

On getting one's bearings

Glittering and glinting against a black velvet backdrop are these ¾-inch high letters spelling Y O U.

Forming this simple word took 43 jewel bearings, those minuscule mechanisms that contribute so much to the performance accuracy of many kinds of instruments.

These particular "jewel" bearings are made of glass, a *not* uncommon practice. Bearings made of glass get their start as cane—cane that we hold in manufacturing to a diameter tolerance of .0235". (Cane, by way of elucidation, is glass

industry jargon for what you probably call solid rod.)

At any rate, spaghetti-like strands of this cane are supplied by us to makers of precision instruments. Our job is purveying preliminary precision; we do *not* make the finished bearings.

Still, the glass itself might be of interest to you, since along with close tolerances, it possesses quite astounding surface hardness.

Specific values are somewhat difficult to spell out because of the conflicting methods extant for comparing various materials.

If you wish to pursue this point further, however, we'll happily supply you with all the details.

As a matter of record, hardness is just one of the many useful characteristics available in the glasses that Corning engineers today.

From amongst the thousands of formulas developed by Corning research, you'll find glasses that selectively transmit or absorb almost every form of radiant energy; glasses lighter than aluminum or heavier than concrete; ribbon-thin or brickwall-thick; sensitive or indifferent to temperature. In fact, you name the *combination* of characteristics desired and there's probably already a glass to fill the bill.

Of necessity this sweeping survey only begins to tell the story of glass as a basic material of design and construction.

For more substantial fare, we recommend one or more of the following: Bulletin B-83: "Properties of Selected Commercial Glassware," a slender but solid compendium of data; "Glass and You," a well-illustrated introduction to the working wonders of glass; or, "New Industrial Uses for Glass," a reprint of a survey article that appeared in *Product Engineering* last summer. Using the coupon will expedite matters.

Wanted: Men with materials problems

If you have a stubborn materials problem that might find its answer in glass, let's get together.

In searching for the answer, you may find it profitable to put to your use our research, application, design and production experience . . . *plus* facilities.

Time and time again we've been pleasantly surprised by the ingeniousness of people who have hit upon some new use for glass—a new use that we've helped put into practical and profitable shape.

Maybe you're next. Write, wire, or call.

Corning means research in Glass

CORNING GLASS WORKS, 52-7 Crystal Street, Corning, N.Y.

Please send me the following material: Bulletin IZ-1, "Glass . . . its increasing importance in product design" ☐; Illustrated Bulletin, "Glass and You" ☐; Bulletin B-83, "Properties of Selected Commercial Glassware" ☐; *Product Engineering* reprint ☐.

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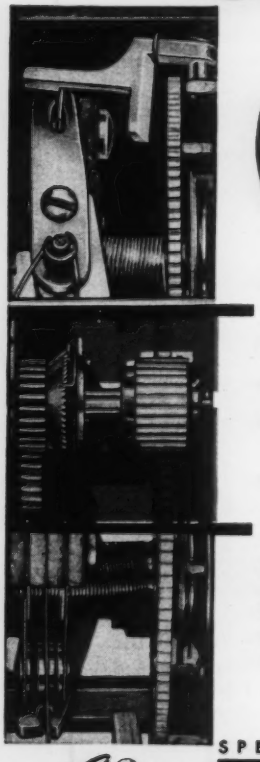
—ITEM 632—

NEW!



CRAMER

automatic reset
INTERVAL TIMER

NEW—Full-vision 300° protected dial for fast, accurate readings.

NEW—Large friction setting knob with integral push button.

NEW—Repeat accuracy within ±½ of 1% of full scale.

NEW—15-amp. open-blade switches, positive quick-make, quick-break operation.

NEW—Multi-position terminal block offers wiring flexibility, side or rear connection.

Powered by the high-torque (30 in. oz. @ 1 r.p.m.) Cramer synchronous motor, the Type 241 Automatic Reset Interval Timer has been designed and tested to new standards for *maintained* accuracy over a long service life. Available in ranges from 15 seconds through 24 hours. Write for complete information.

SPECIALISTS IN TIME CONTROL

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Cramer TIMING DEVICES

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—ITEM 633—
For More Information Circle Item Number on Yellow Card—page 19

The Engineer's Library

and refrigeration, heating and ventilation, industrial processes, mechanical draft, dust collection and control, and fluid-drive power transmission. A concluding section contains 50 tables and charts.

•

Design of Piping Systems, 2nd Edition. *By contributors from the M. W. Kellogg Co. and the Massachusetts Institute of Technology; 365 pages, 8½ by 11 in., clothbound; published by John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; available from* MACHINE DESIGN, *$15.00 postpaid.*

The objective of this second edition is to supplement the ASA Code for Pressure Piping with specific mechanical design approaches for entire piping systems and their components. Subjects expanded in this edition concern local flexibility, stress intensification and flexibility analysis under various loadings. Chapter subjects are: strength and failure of materials; design assumptions, stress evaluation and design limits; local components; methods of flexibility analysis; expansion joints; supporting, restraining, and bracing piping systems; prevention and control of vibration.

Government Publications

Catalogs of Technical Reports. *8 by 10½ in., paperbound; published by and available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; 10c each; numbers and titles as follows:*

CTR-310 **The Transistor**—3 pages
CTR-319 **Cermets**—4 pages
CTR-244 **Magnetic Amplifiers**—4 pages

Technical reports available from the Office of Technical Services are primarily the results of research done by the Government or by private laboratories with Government sponsorship. German papers captured in World War II are included. Items in these catalogs include report title, original reporting agency, date, number of pages, source of copies and cost per copy. Summaries of contents are included occasionally.

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"My unique closed cellular structure will not absorb oxygen, moisture, dust, dirt—even at cut edges—eliminates need for special coating or molded-on skin.

"There's no restriction on my outline of shapes and I can be cut to any size.

"What's more, my inert nitrogen-filled cells offer greater cushioning and resiliency than other soft rubber materials."

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GREAT AMERICAN INDUSTRIES, INC.
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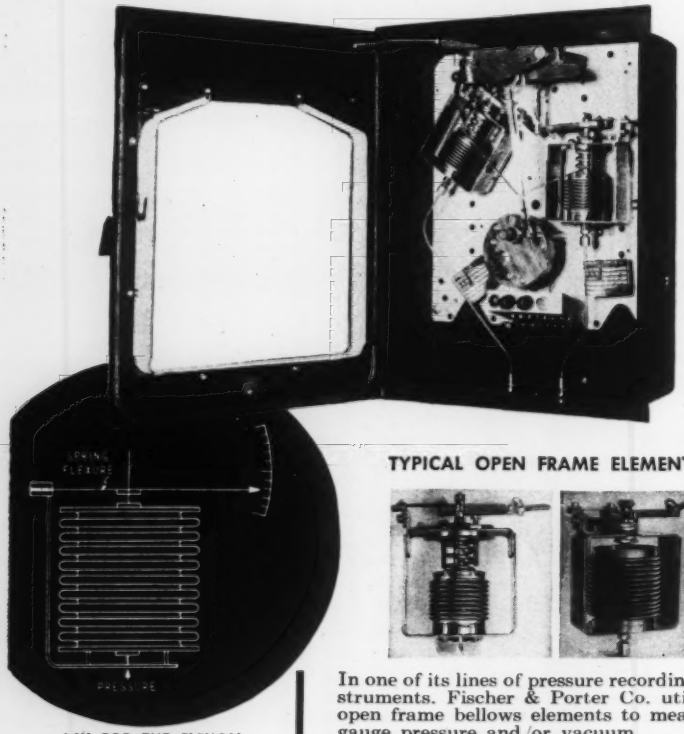
FLEXON® BELLOWS *Design Briefs*

Dual Pressure Recorder Employs Open Frame Bellows Elements



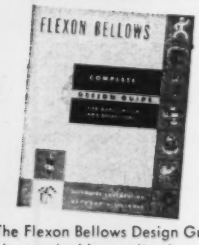
TYPICAL OPEN FRAME ELEMENTS

In one of its lines of pressure recording instruments. Fischer & Porter Co. utilizes open frame bellows elements to measure gauge pressure and/or vacuum.

These elements consist of a bellows mounted on a rigid stainless steel mounting frame. The schematic drawing above shows the operating principle. The heart of the element is a Flexon bellows. Like all Flexon Bellows, these are cost-engineered. Flexonics engineers who know and understand controls develop bellows matched to the instrument in which they will be used. Charging media, end fittings, materials, etc. are selected to fill all the needs of the instrument at minimum cost.

We would like the opportunity to examine your requirements in bellows for instruments and controls. We may be able to show you the way to lower costs. Send an outline of your requirements.

ASK FOR THE FLEXON BELLOWS DESIGN GUIDE



The Flexon Bellows Design Guide gives valuable application and design information. Write for your copy, today.

See us at the Instrument Show—Booth 1609-10

B-38

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Manufacturers of flexible metal hose and conduit, expansion joints, metallic bellows and assemblies of these components.
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

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proved in service and backed by over 54 years manufacturing experience

—ITEM 635—
For More Information Circle Item Number on Yellow Card—page 19

New Machines

Domestic

Portable Phonograph: Model T325B Melody Master phonograph has an amplifier system with power output of 3 w. System incorporates three amplifier tubes plus a rectifier, and employs push-pull output stage. Cross-over network frequency is 4000 cps. Equipment includes compensated volume control and variable tone control. Machine is equipped with a 6-in. speaker with sound diffusers and a 4-in. high-frequency speaker, both front mounted. Record changer is a three-speed intermix type with dual sapphire styli. The unit is lightweight and is finished in a choice of three colors. Equipped with a handle, the phonograph is 9½ in. high, 17⅝ in. deep and 15 in. wide. *Magnavox Co., Ft. Wayne, Ind.*

Portable Typewriters: Redesigned Quiet-riter models are available in four decorator colors. Keyboards on these models are standard 44-key, 88-character. Carrying cases are included. *Sperry Rand Corp., Remington-Rand Div., New York.*

Materials Handling

Mobile Crane: Model KE Karry Krane, with 10,000-lb capacity, moves any shaped load that can be placed under its boom and is designed to work either in or out of doors. Power steering, trunnion type steering wheels, short turning radius and rounded rear end design enable the unit to maneuver easily and quickly in crowded areas. Boom lengths of 9, 10 or 12 ft are adjustable to six positions for reaching into road trucks and box cars. The unit is operated with automotive type driving controls and one spring-loaded lever to operate hoist drum. The drum automatically returns to neutral when released, engaging a brake to hold the load. Synchronizing constant-mesh transmission assures fast,

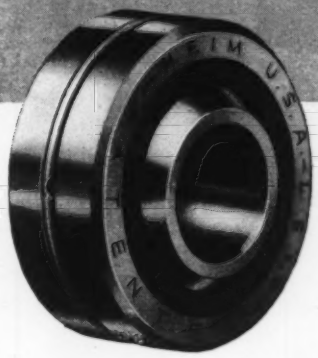
HEIM

has a bearing

FOR YOU

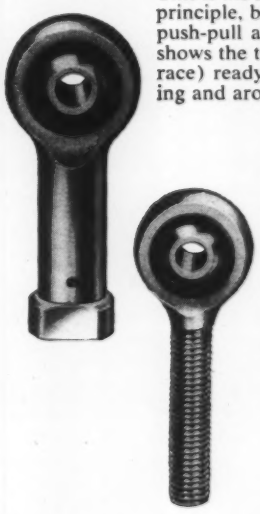
With a half century of experience in the anti-friction bearing industry, it was only natural to expect from The Heim Company origination of the modern methods in producing Unibal, the single ball spherical bearing.

Heim pioneered not only in the perfecting and manufacture of the spherical bearing, but in its introduction to American, as well as foreign, manufacturers.



The single ball (Unibal) construction, because of its free action, compensates for shaft misalignment and deflections in all directions. There is ample provision for lubrication around the ball, and the greater supporting area carries heavier loads.

This is the Heim Unibal Rod End. It operates on the same principle, but is mounted in a suitable housing for use in push-pull applications. The exploded view, at the right, shows the two bronze bearing inserts (the race) ready to be expanded into the housing and around the ball.



Heim Unibal Spherical Bearings are available in a wide range of stock sizes, the Rod Ends are made in both male and female types, and complete stocks are carried by bearing distributors throughout the country.

It is not only the low price of the Unibal Rod End, but the simplicity of attaching it that bring the overall cost down. Many applications require only a drilled and tapped hole for the male rod end — or a drilled hole, with a bolt or screw for the female type.

Please write for complete catalog and name of nearest Direct Factory Representative or Distributor. Heim Unibal is also manufactured, under license, in England, Germany, Switzerland and other European countries.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

SELF ALIGNING
BALL BEARING FLANGE UNIT

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BALL BEARING PILLOW BLOCK

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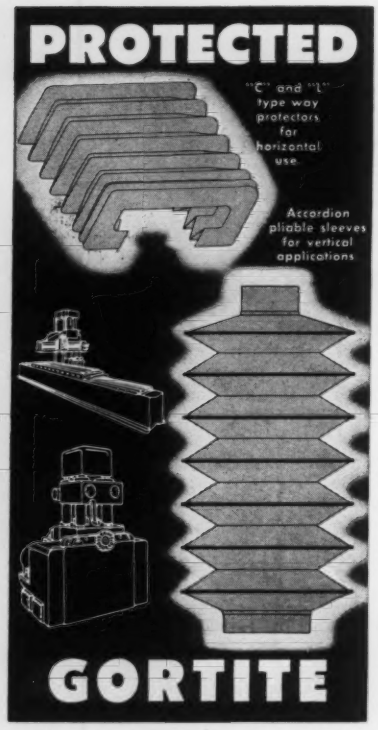
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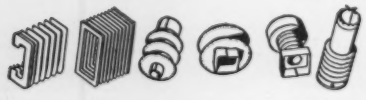

Many shapes and contours, like these shown here, are described in a NEW bulletin SPC-2: Zippers and special, duPont coatings extend the range of usefulness for dirt exclusion and lubricant retention. Fabricated from duPont (neoprene-base) materials GORTITE parts last from 3 to 5 times longer than molded rubber. For bulletins, layouts, designs and estimates write or wire to—

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—ITEM 666—

New Machines

easy shifting. Load lifting speed is 75 to 108 fpm; lowering speed is 165 to 240 fpm. Heavy-duty, four-cylinder gasoline engine delivers 49 hp at 2400 governed rpm. All components are readily accessible with a hood which opens from either side. Single-part hoist lines, for capacities to 6000 lb, or two-part lines, for capacities to 10,000 lb, are available. *Hyster Co., Portland, Oreg.*

Fork Lift: Super 55 fork lift has a lifting capacity of 4000 lb and 8 or 10-ft tilting mast to accommodate standard forks in four lengths, concrete block fork, ½-yd hydraulic scoop bucket or dozer blade. Large 12-29 tires assure full traction in unpaved areas as well as in mud and snow. Six forward speeds from 1½ to 14½ mph are available in addition to high and low reverse speeds. Extremely maneuverable, the unit has a turning radius of 10 ft, and is equipped with hydraulic power steering. *Oliver Corp., Chicago.*

Swinging Shoe Carrier: SC-60 carrier, available in six sizes, has a lifting capacity of 60,000 lb. Steel shoes swing outward, close and lock by one-lever control, hydraulically actuated. Capacity loads are lifted hydraulically by an individual lever. Sloping radiator, short hood and deep windshield provide good visibility to front, rear and bottom. The carrier is equipped with power steering. Engine is 6 cylinder, 180 hp, 558 cu in. displacement, rated at 2600 rpm. A 150-hp diesel engine is also available. Load widths accommodated in the six sizes range from 58 to 74 in.; load heights from 60 to 66 in. All sizes have 162-in. wheelbase and 12 ft 8 in. turning radius. *Gerlinger Carrier Co., Dallas, Oreg.*

Metalworking

Drilling Machine: Class 8 drill is available with two drives, providing spindle speed ranges of 2450 to 3540 rpm or 2450 to 6000 rpm. It drills to the center of a 6-in. circle, has 9/16-in. diam spindle and spindle feed of 2¼ in. Distance from chuck to 5⅝-in. diam round table is 9½ in. Optional 6 x 8-in. rectangular table which overlaps the base to form

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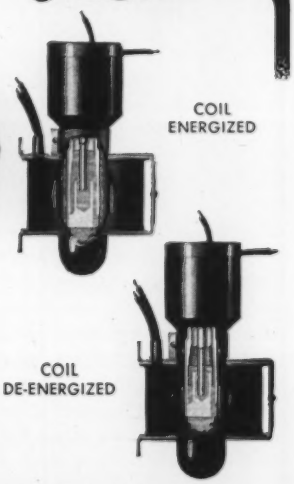

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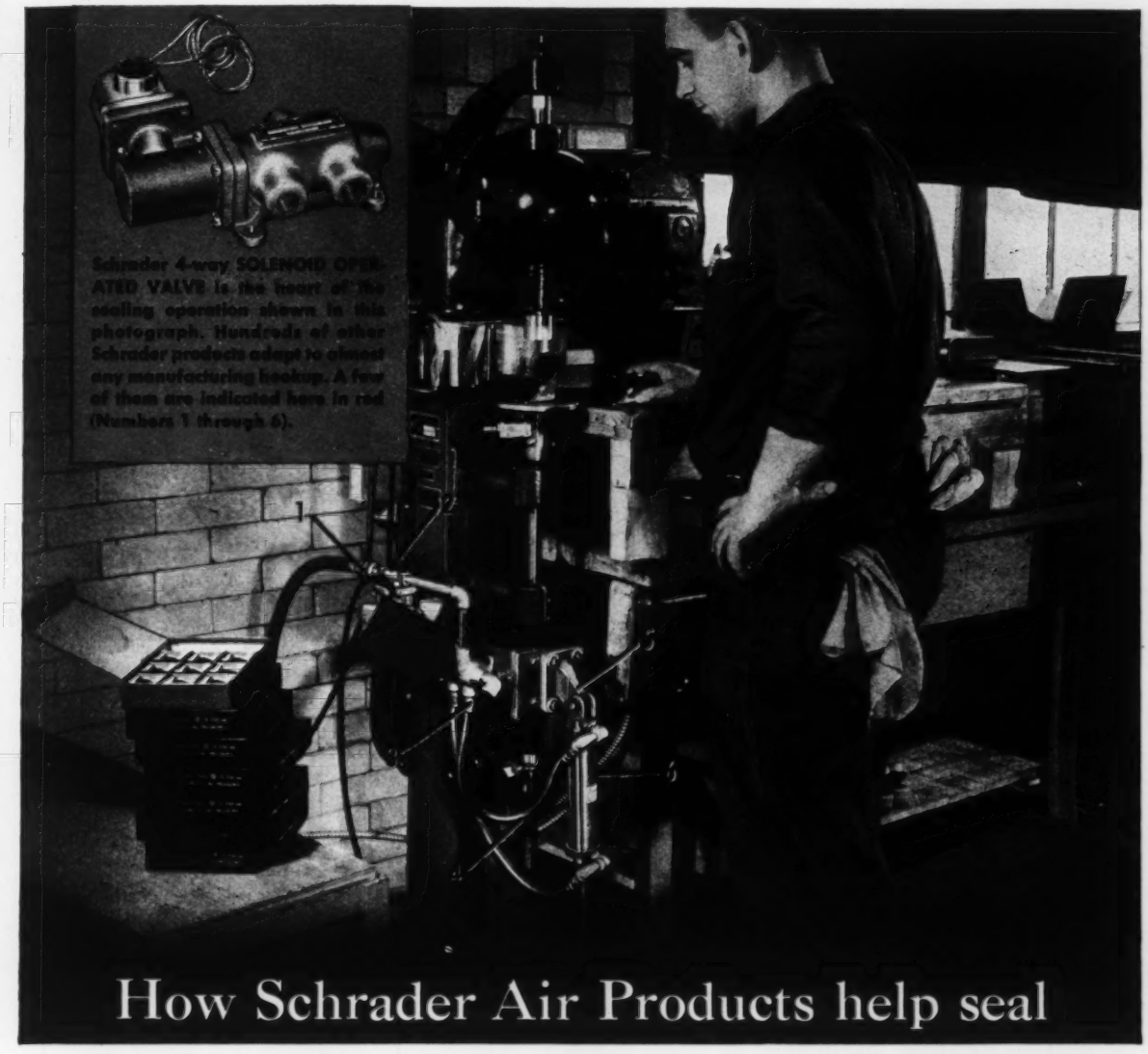
Send for Bulletin 800

—ITEM 637—


Schrader 4-way SOLENOID OPERATED VALVE is the heart of the sealing operation shown in this photograph. Hundreds of other Schrader products adapt to almost any manufacturing hookup. A few of them are indicated here in red (Numbers 1 through 6).

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—ITEM 638—
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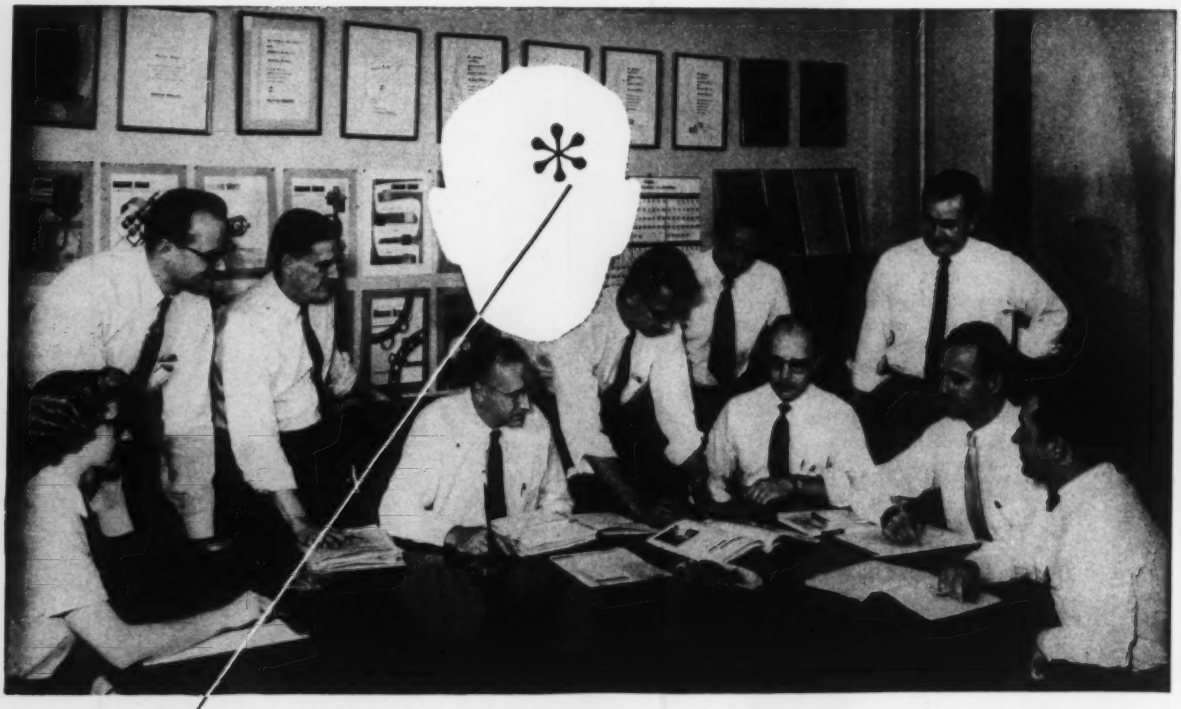

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• He will work on a stimulating job that provides interesting contact with diversified problems in a variety of engineering areas.

• Additionally he will be encouraged to progress as a specialist in one or more of the branches of design engineering.

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• He should be able to write fluently and well, and should show evidence of such ability.

• Duties include the procurement, selection, writing and editing of articles and feature departments.

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a continuous work surface when set up in gangs is also available. Standard motor is 110-v, single-phase. The drill occupies a space of 7 x 19 in. and is 25 in. high. *High Speed Hammer Co. Inc., Rochester, N. Y.*

Die Caster: Model BH-60 1000-ton die casting machine is available either in a plunger gooseneck design for the production of zinc castings or in a cold chamber design for making aluminum and magnesium castings. Solid steel die plates, 10 in. thick, measure 72 x 54 in. and provide die space of 40 x 32 in. between tie bars. Die opening stroke of 24 in. is completely adjustable for less stroke if desired. Hydraulic system can put the machine through eight free cycles per minute with injection pressures of up to 32,000 psi and injection speeds of up to 1000 fpm. The unit injects up to 49 lb of zinc and more than 14 lb of aluminum into the die with electrical pushbutton movement required for a fully automatic cycle of operation. *Kux Machine Co., Chicago.*

Cutting Machine: Model 28 Sever-All high-speed oscillating dry-abrasive cutting machine handles solid steels up to 4 in. square, 6 in. angles and 8 in. channels at 90 deg to axis. It uses an 18-in. diam abrasive cutting wheel, 10-hp motor and spindle speed of 2450 rpm. The machine is available in both stationary and portable models for cutting sheets, angles, channels, pipes, bar stock, tubes and solids of practically all analyses. Oscillation enables cutting with a minimum of pressure on the wheel. Front and sides of the machine are enclosed by removable steel plates to protect machine parts against dirt and damage. Cutting wheel is totally enclosed during the cutting operation except for openings on the sides of the guard to clear the work. Unit is 56 in. deep, 32 in. wide and 62 in. high. *American Chain & Cable Co. Inc., Bridgeport, Conn.*

Broaching Machines: Electro-Gear dual ram vertical broaching machines with 15-ton capacity have helical pinion rack drives and

NEW Precision in a Small Package

TyniSWITCH

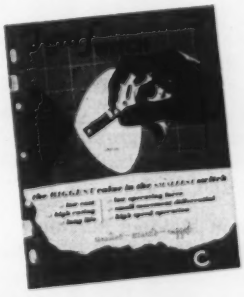
...if your Precision Snap Switch must have:

Excellent Repeatability
Low Operating Force
Small Movement Differential
High Shock Resistance
Built-In Overtravel
Virtually "Bounceless" Operation

Precision performance and outstanding contact life are features of the new TyniSwitch. Smaller than other snap switches of equal rating, it is 1⅝ inches long, 9/32 inch thick, and 7/16 of an inch wide.

Fully enclosed and extremely compact, TyniSwitch is of the simplest design. Force and movement are held to very close tolerances, and the patented blade design produces a fast and positive snap-action that is virtually "bounceless."

TyniSwitch is available in four basic designs, varying in operating force from 3 ounces up to 12 ounces in the pin operated models, and from 1½ to 12 grams in the wire operated models.



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Canadian Standards Assoc. approved 15 Amp. 125 V. AC
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Bulletin 263 gives basic data and describes the designs available. Write for your copy today.

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—ITEM 639—

Whether you're a production man, plant engineer, designer of original equipment, or a manufacturer looking for ways to reduce costs and overhead—there's a way that real savings can be built into machinery used in your industry!

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P-4

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Rochelle Park, New Jersey

Pioneers in Automatic Lubrication

—ITEM 640—

New Machines

balanced power loading. Pinion-rack drive is powered by a variable speed dc motor powered by a motor generator set. Five basic models are available with stroke lengths of 54, 66, 80, 90 or 100 in. Hardened and ground box type or Vee ways and broaching speeds up to 80 fpm or more are available on all models. Ram speed is infinitely variable between minimum and maximum limits. Ram ways are pressure lubricated; all gears are automatically lubricated. Hydraulic power is provided to operate work holding fixtures, and is interlocked with the machine cycle. All hydraulic and electrical controls are interlocked and meet JIC standards. Tables and fixtures are hydraulically actuated. *Colonial Broach & Machine Co., Detroit.*

Processing

Ultrasonic Degreaser: Degreasing unit is designed for rapid and thorough cleaning of fabricated parts up to 8 x 8 x 10 in. Two cleaning stages, vapor degreasing and ultrasonic solvent cleaning, are provided, and can be used in any order. The machine utilizes solvents such as trichlorethylene. Built-in components consist of pump, filter, solvent spray, heater, thermostats and vapor condenser. The degreaser is available in stainless-clad or zinc-clad steel, or solid stainless steel. Ultrasonic transducer can be moved in its compartment and is removable. Ultrasonic power up to 500 w at 40 kc frequency is available over an area of 7 x 9 in. Generator is housed in a separate unit. The equipment operates on 110-v, 60-cycle power, and consumes approximately 2500 w maximum. *Curtiss-Wright Corp., Wood-Ridge, N. J.*

Injection Molding Machine: Redesigned Model 616-L-12 plastics injection molding machine accommodates molds measuring 14½ x 24 in. It dry cycles 360 times per hour, molds up to 20 cu in. per shot, plasticizes 100 lb of material per hr, and shoots 12 oz of polystyrene with prepacking. Redesigned power plant provides injection pressures to 21,000 psi. Operations are timer-controlled and

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"Standardized" Geared Selective Type

These self-contained, compact all geared type change speed Units are available in 2, 3 and 4 speed changes, providing definite ratio of speed reducing, speed increasing (or a combination of both). They were designed to fill industry's need for a very efficient, precision-built *standardized line* . . . to eliminate the high cost and delayed delivery of specially designed units. They are ideal for use on wire drawing machines, large machine tools, mixing equipment, sludge pumps, extruding machines, dry cleaning equipment, etc. Gears and pinions are Sykes Continuous Tooth Herringbone type, and shafts, bearings, clutches and housings are of the finest quality to assure the user of long, trouble-free service . . . Ratings are according to AGMA Standards, with allowance for 100% overload in starting and for momentary shock loads; these units are also designed to permit the heavy overhung loads resulting from the use of sprockets or pulleys.

Send for Catalog CSU-54, and kindly use your Business Letterhead when writing for same.

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Right at your desk, make a detailed inspection of Century's Fractional H.P. single phase and polyphase line of motors, designed to latest NEMA standards! This fact-filled new book gives you the comprehensive story on Century's *new* 48-Frame and 56-Frame INDUSTRIAL QUALITY Motors... tells how and why they're *better performers* than the older models, why they weigh less, take less space, are easier to handle.

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—ITEM 642—
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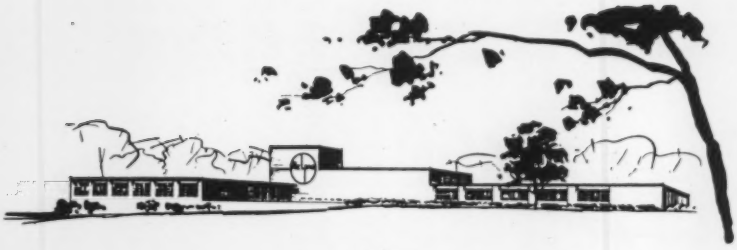
Electronic & Mechanical
PHYSICISTS:



Top Grade Openings At Melpar *Leader in Electronic Research & Development*

Due to our continuing expansion program, a number of top grade openings exist in our new laboratories suburban to Washington, D.C. We urge you to consider the following:

1. At Melpar the engineer is not tied to a pre-arranged schedule of advancement. Instead, promotion and advancement are based on *individual recognition*, where skill and ability are the paramount factors of determination.

2. Melpar has doubled in size every 18 months for the past 10 years. New openings occur constantly. This enables the engineer to advance to positions of increased responsibility *as soon as he is ready.*

3. Our unique "project team" basis of organization gives the engineer an opportunity to participate in *entire* problems from conception to completion of prototype, and thus experience the "overall" approach to engineering problems necessary to eventual directorship responsibility.

4. Our new air-conditioned laboratories encompass over 285,000 square feet and offer *complete* facilities for creative research and design. In addition to our central Model Shop, supplementary facilities, personnel and test equipment are available for *immediate* use within each project group.

5. The Northern Virginia Area, suburban to Washington, D. C., in which Melpar is located, offers excellent living conditions, enjoys the Nation's highest per capita income, fine homes and schools. Recreational, cultural and educational facilities abound. Fully-accredited graduate courses are offered at the Melpar laboratories and at 5 universities in the Area.

Top Grade Openings Exist in These Fields:

Network Theory • Systems Evaluation • Microwave Technique • UHF, VHF, or SHF Receivers • Analog Computers • Magnetic Tape Handling • Digital Computers Radar and Countermeasures • Packaging Electronic Equipment • Pulse Circuitry • Microwave Filters • Flight Simulators • Servomechanisms • Subminiaturization • Electro-Mechanical Design • Small Mechanisms • Quality Control and Test Engineering

Write for complete information. Qualified engineers and physicists will be invited to visit Melpar at Company expense.

Write: Technical Personnel Representative

MELPAR *Incorporated*

A Subsidiary of Westinghouse Air Brake Company

3129 Arlington Boulevard, Falls Church, Virginia

Positions also available at our laboratories in: Cambridge, Mass., 99 First St., Watertown, Mass., 11 Galen St.

—ITEM 643—

For More Information Circle Item Number on Yellow Card—page 19

New Machines

variable. Clamp pressure, injection pressure, temperature of molding materials and operating cycle can be adjusted at the front of the machine. Combined with a 200-ton clamping mechanism, it produces large moldings with minimum scrap. *Lewis Welding & Engineering Corp., Machine Div., Cleveland.*

Electric Furnace: High-temperature inverted pit-type furnace, designated Model IP-6700, has an elevator type closing arrangement which permits the door, when lowered, to serve as a hearth that can be rolled to the front of the unit. The furnace is thus adaptable to a variety of work, especially where heavy parts or crucibles containing molten glass or metals are to be handled. The parts are loaded onto the hearth or door which is rolled on tracks back to position and raised to the pit-type work chamber. Chamber size is 18 x 18 x 21 in. Raising of the hearth, which will take a work load of approximately 150 lb, is by a safety hand ratchet. Power lift equipment is also available. Operating temperature is up to 2750 F; heat-up period (to maximum) is 3 or 4 hr. Power rating is 35 kw, 220 v, 60 cycle, 3 phase; 440 v is also available. Power controls include voltage regulating transformer with fine to coarse switches (36 taps), direct reading power input ammeter and magnetic contactor. Controls are mounted in a heavy steel panel, internally wired. *Pereny Equipment Co., Columbus, O.*

Micron-Grinding Machines: Improved micronizer units are designed to reduce solids to particles in the micron range at a solid feed rate of up to 1½ tons per hr. The units operate on the principle of high speed rotation of particles caused by jets of compressed air or steam at angles to the periphery of the shallow grinding chamber. The particles, through violent impact, tend to pulverize each other. Materials processed include titanium dioxide, sulfur, talc, iron oxide pigment, cryolite, Fuller's earth, anthracite coal, DDT (50 per cent) and procaine-penecillin.

Seven sizes are available with capacity ranging from ½-lb per hr in the smallest size to 3000 lb per hour in the largest. Fabrication material of the machines is usually dependent upon the characteristics of the substance to be ground. *Sturtevant Mill Co., Boston.*

Testing and Inspection

Gear Tester: Red Ring Model GSR unit incorporates an electronic sound discriminator which automatically inspects and rejects gears, based on operating sound level, thus providing precise selection of gears having uniform sound characteristics. Completely automatic, the gear speeder handles smaller sizes of pinion gears. Gears are automatically loaded, run in both directions in mesh with another gear with and without brake loading, unloaded, and passed or rejected by the sound discriminator unit. Microphone is located near the gear mesh area. Unit is adjustable at any time to the range of audible noise frequency and intensity desired for rejection. The speeder sound tests up to 14,000 pinions in 8 hr. Push-button controls are included for each machine function. Air cylinders control work arbor, loader and brake functions. Separate electrical and pneumatic control panels are mounted away from the speeder unit to remove noise sources from testing area. Panels have sound-suppressed construction. *National Broach & Machine Co., Detroit.*

Brinell Hardness Tester: Motorized machine automatically indicates the diameter of the Brinell impressions. Loads are applied by dead weight, through a motor drive, with cycles adjustable from 5 to 60 seconds. Built-in optical system automatically projects a magnified image of the indentation on a ground glass screen. Test loads from 120 to 3000 kg are available. Vertical clearance is 16 in., horizontal reach, 8 in. The tester operates on 220-v, 3-phase power. *Gries Industries Inc., Testing Machines Div., New Rochelle, N. Y.*

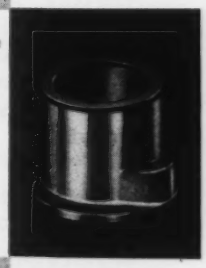
time to re-examine

BEARING APPLICATIONS

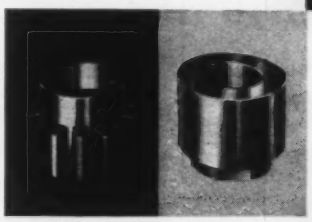
Striking cost reductions in bearing applications in many mechanical products are made possible by the use of Bunting Sintered Powdered Metal Bearings and parts.

Bunting engineering counsel can guide you in the selection of designs and alloys that will provide bearings of exactly the type, design and material that will fully meet both cost and functional requirements, whether the material be Cast Bronze or Sintered Metal.

A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command comprehensive data and facts based on wide experience in the designing and use of cast bronze and Sintered Powdered Metal Bearings and parts.



Write to our Product Engineering Department in Toledo or consult our nearest Sales Engineer.



Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

—ITEM 644—

PIPE THREAD with

TRU-O-SEAL

TEFLON SEAL

Does away with messy pipe "dope" compounds!

PAT. PENDING

. . . Eliminates valve and pump damage caused by overtightening of leaky joints.

. . . "TEFLON" SEAL is immune to ALL hydraulic fluids and to steam, air, water, solvents and practically all gases and chemicals!

. . . Withstands temperatures from —100° F. to plus 500° F.!

. . . Fully field tested and proven by leading manufacturers!

EASY INSTALLATION!

1 Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).

SEAL SIDE

2 Thread pipe or fitting 4 threads into port. Point in desired direction.

3 Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

TRU-O-SEAL stops present pipe thread leaks instantly, prevents future leaks, saves cost and labor of special or welded fittings. For 3000 psi operation (15,000 psi minimum proof pressure). Comes in ⅛" to 2½" pipe thread sizes.

Write for Prices and Complete Data

TRU-O-SEAL DIVISION
Flick-Reedy Corporation

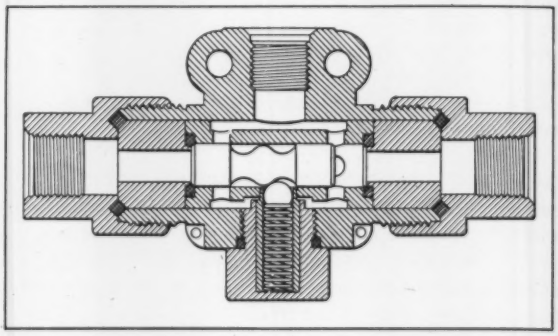
2006 N. Hawthorne Ave. Melrose Park, Ill.

"Miller Fluid Power" is also a division of Flick-Reedy Corp.

NOTEWORTHY Patents

Automatic Selector Valve

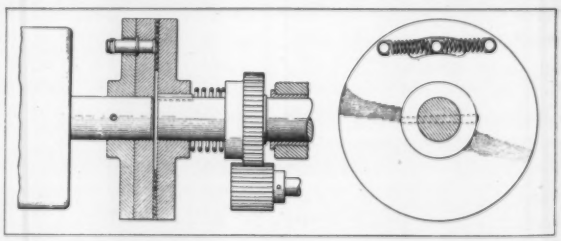
Instantaneous emergency connection of an auxiliary or standby fluid pressure source to a fluid-actuated device is accomplished by an automatic source selector valve. Designed for application in hydraulic systems, such as landing gear actuating circuits, the valve operates automatically on complete failure or



substantial reduction of primary source pressure. Double-ended shuttle, indexed by a ball-spring detent mechanism, translates to connect highest pressure source with device being actuated. Contamination of primary source fluid by the standby supply is prevented by valve overlap, arranged so that neither passage leading to the device is uncovered until the other passage is completely blocked. Restoration of the main pressure supply automatically resets the valve. *Patent 2,729,226 assigned to Kenyon Instrument Co. by David W. Jones.*

Vibration-Absorbing Coupling

Shaft-excited oscillations of cams, control components and similar vibration-sensitive elements are screened from the shaft input by a vibration-absorb-



ing coupling. Incorporating tandem friction-disk and spring-action vibration absorbers, the unit passes steady rotational motion, but intercepts torque oscillations in the 2 to 5 cps frequency range. Torque path is from the axially-moving, spring-load-

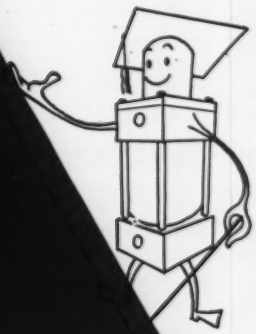
—ITEM 645—
For More Information Circle Item Number on Yellow Card—page 19
Facing Page—ITEM 646→

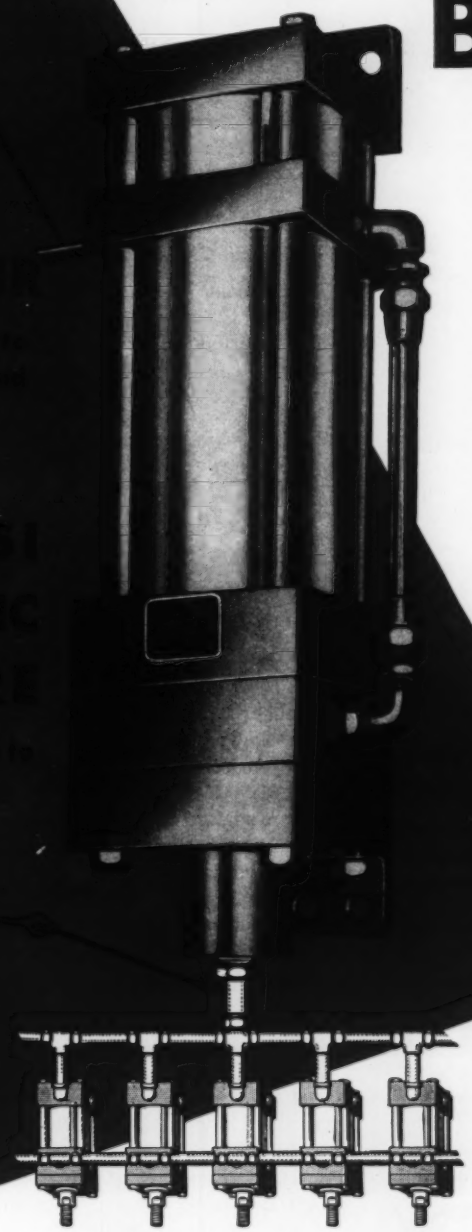
Miller

FLUID PRESSURE BOOSTERS

- Save space, weight and investment cost by replacing pump installations in many applications
- Less costly to install, operate and maintain
- **Hold pressure indefinitely** without the motion and heat generation of ordinary pump circuits
- Provide — at point of cylinder thrust — more efficient power with less weight in less space than direct driven air cylinders
- Save up to 95% of air consumed by direct driven air cylinders
- Operate at speeds of 30 to 450 strokes per minute

NOTE: In addition to its most complete line of "Custom-Built" Boosters available on normal delivery, Miller offers 5" bore, 25 to 1 ratio boosters for immediate delivery in either 6" or 12" stroke. Write for data and prices.





FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST
Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

...CIALLY RECOMMENDED FOR

- **WELDING**
- **PUNCHING**
- **SHEARING**
- **CLAMPING**
- **RIVETING**
- **CRIMPING**
- **PRESSING**

and similar applications

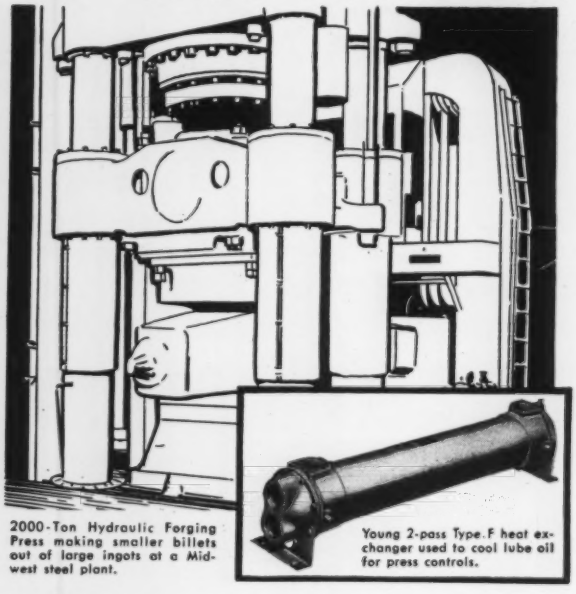
SALES AND SERVICE FROM COAST TO COAST

...EVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • ...STON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND ...IDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS ...WAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • ...FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO ...OUSTON • TORONTO, CANADA and OTHER AREAS

Miller

2006 N. HAWTHORNE AVE. • MELROSE PARK, ILL.

Young Cools Controls For 2000-Ton Giant



2000-Ton Hydraulic Forging Press making smaller billets out of large ingots at a Midwest steel plant.

Young 2-pass Type F heat exchanger used to cool lube oil for press controls.

Young Heat Exchanger Cools Controls for Hydraulic Forging Press

Every time this monster press slams down its 2000-ton fist, it responds to the accuracy and efficiency of master press controls. All component parts of these vital controls must be of absolute dependability. For this reason Young Type F heat exchangers were specified to cool lube oil for the press control motors.

Besides their reputation for dependability, compact Young heat exchangers offer greater initial and operating economies, and more cooling surface per unit volume of space. Construction features include: (1) Smooth flow bonnet that distributes fluid with minimum turbulence; (2) Corrosion-resistant tubes brazed into casting; (3) Quality gasket eliminates fluid by-passing or leakage; (4) Baffles made to close tolerance. Model F available in stock for immediate delivery, or removable tube bundles built from standard stock parts. Both available for fresh or salt water.

Write for FREE Catalog #1254

Put Young Talent to work for you . . .

Solving heat transfer problems is what we do best because it is our very reason for being. You, too, can harness the power of Young engineering talent. Write, wire or call without obligation.

Dept. 306-G

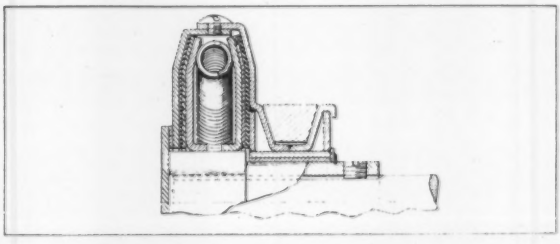
Young RADIATOR COMPANY
RACINE, WISCONSIN
Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY
Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.
Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

Noteworthy Patents

ed driving disk to the friction-faced intermediate disk. Slippage between driving disk and friction facing blocks out low-amplitude input vibrations in the 5 cps range. Vibrations passing the friction coupling, which may be in the 2 cps, higher-amplitude range, are intercepted by the spring coupling connecting the intermediate and output disks. *Patent* 2,729,078 *assigned to Streeter-Amet Co. by Frank Schmidt.*

Centrifugal Clutch

Engagement of a centrifugal clutch, designed for low starting torque power sources, is delayed until preset rotational speed is attained. A heavy, close-wound helical spring is used as a centrifugally actuated weight. Free-running clutch plates, nested in



the rubber-faced inner walls of the clutch housing, move axially and rotate with the hex-ended input shaft. Acceleration of the input shaft and clutch plate assembly centrifugally expands the helical spring, wedging the clutch plates into frictional engagement with the inner housing faces. Deceleration below engagement speed allows the helical spring to contract uniformly, permitting the plates to move toward each other and disengaging the clutch. *Patent* 2,729,320 *assigned to Gateway Engineering Co. by Henry G. Henrickson.*

Magnetic valve utilizes metallic particles concentrated or dispersed by an externally controlled magnetic field to regulate the flow of corrosive or abrasive fluids, or fluidized solids. Valve is "closed" when particles are forced to concentrate at a point within the valve body. Valve is "open" when particles are dispersed as an evenly distributed layer. *Patent* 2,743,898 *assigned to Esso Research and Engineering Co. by William H. King.*

Spring and pin mounting design provides simple method for fixing gears to shafts without keyways, splines or other broached elements. Pin passing perpendicularly through shaft is spring-constrained to a V-groove in the gear face. If gear rotation is blocked, pin slips from groove, providing overload protection for the driven mechanism. *Patent* 2,744,-396 *assigned to Northrop Aircraft Inc. by Michael J. Nagey and Donald M. Threewit.*

Simple Arithmetic...

Type 302, Sheet Base Price 44.50 cents per lb.

Type 430, Sheet Base Price -34.50 cents per lb.

Saving 10.00 cents per lb.

in Stainless SHEET Costs!

Now You Can SAVE $200 Per Ton!

Many designers and fabricators who are currently using Type 302 stainless can, in numerous applications, specify Type 430 straight chromium stainless and take advantage of the 10 cents per pound difference in base price. Some of our customers are already saving more than $200 per ton using our 430 MicroRold stainless sheet.

The steel industry estimates that 50% of all stainless sheet applications could satisfactorily employ Type 430, the least expensive of all stainless grades, as an economical and practical material. When properly applied, Type 430 has all the desirable qualities of beauty, corrosion resistance, strength, long life and low maintenance that no other material, except stainless, can offer.

We are currently producing our MicroRold Type 430 sheets in thicknesses .005" to .109" with 2B or 2D finishes; and in thicknesses .010" to .109" in No. 3, 4 and 7 finishes.

Send for Your copy, "Care and Use of 430 MicroRold Stainless Steel"

Washington Steel *Corporation*

7-E WOODLAND AVENUE, WASHINGTON, PA.

—ITEM 648—

For More Information Circle Item Number on Yellow Card—page 19

ROCKFORD

This →

*TRADE MARK

"MORLIFE clutch has gone 831 hours without slipping or adjustment."

"MORLIFE clutch going strong after 1693 hours, working in sand."

"MORLIFE clutches last 950 hours longer, without adjustment."

"MORLIFE clutch needs adjustment once a month, instead of daily."

"MORLIFE requires lighter handle pull and one tenth the adjustments."

is the Clutch that the nations largest makers of heavy duty machines are showing as a NEW feature

New MORLIFE* CLUTCHES and CLUTCH PLATES Give—

MORE Clutch Life (400% MORE)
MORE Torque Capacity (100% MORE)
MORE Heat Resistance (50% MORE)

These *new* ROCKFORD Clutches and Clutch Plates have been developed by ROCKFORD Clutch Engineers to take full advantage of recently discovered facing material. Actual field tests on heavy duty equipment have resulted in adoption of MORLIFE clutches by builders of tractors, earth movers, graders, shovels, cranes, trucks, oil field equipment and power units. For information how these *new* Rockford MORLIFE Clutches will improve the operation and increase on-the-job hours of heavy duty machines, write Department E.

"MORLIFE pulls harder and lasts six to ten times longer."

"Won't buy a unit that isn't equipped with Durable MORLIFE clutch."

B. W. ENGINEERING MAKES IT WORK

ENGINEERING B-W PRODUCTION

B. W. PRODUCTION MAKES IT AVAILABLE

ROCKFORD
Clutch Division
BORG-WARNER

311 Catherine St., Rockford, Ill.
Export Sales Borg-Warner International
79 E. Adams, Chicago 3, Illinois

CLUTCHES

—ITEM 649—

OHIO CUSHIONED ADJUSTABLE FEET with *NEW* non-marking gray neoprene pad

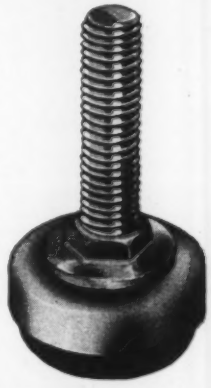
A handsome sturdy part that provides suction to hold appliance in place, absorb vibration, prevent marring of floors and improve product appearance.

USED ON:

- Deluxe Home Appliances
- Electronic Equipment
- Large Air Conditioners
- Movable Office Partitions
- Game Tables
- Office Equipment

Now available from stock in two popular sizes:

1/2 —13 x 2"
5/16—18 x 1 1/2



1905 Over 50 Years of dependable service 1956

Specialists in the Manufacture of Weld Fasteners and Adjusting Screws

THE OHIO NUT AND BOLT COMPANY

38 First Avenue Berea, Ohio

—ITEM 650—

push-pull CONTROLS

Compression & Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. ¾" minimum bend radius.

Three Types:

1. *Light Duty*—Compression Ult. Load 1250 lbs.; Ult. tension 960 lbs.
2. *Heavy Duty*—Compression Ult. Load 1650 lbs.; Ult. tension 960 lbs.
3. *Extra Heavy Duty*—Compression Ult. Load 3050 lbs.; Ult. tension 3900 lbs.

Modernize your push-pull control system with Southwest Mechanical Push-Pull Controls. Eliminate bell cranks, pulleys, and dual cables. Send for ENGINEERING MANUAL giving detailed prints and complete specifications covering materials, finishes, capacities. Please address Dept. MD-56.

SOUTHWEST PRODUCTS CO.
1705 So. Mountain Ave., Duarte (Los Angeles County), Calif.

—ITEM 651—

Ship products safely

Protect openings and studs this low-cost way

S.S.White protective plastic plugs and caps are simple, low-cost safeguards against damaged threads, dirt, moisture and leakage. They're easy to use, low in cost, and insure safe, factory-perfect delivery of your products. Also ideal for masking and protection during painting, plating and other production processes.

SAMPLES AND LITERATURE ON REQUEST
Send for Bulletins P-5312 and P-5203 for full details. Samples of your specific size and style of plug or cap on request. Address Dept. 4P.

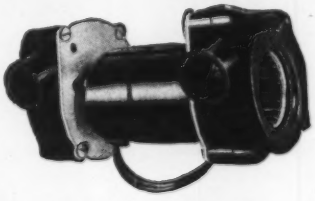
S.S.WHITE PLASTICS DIVISION
10 East 40th St., New York 16, N. Y.

C-8

S.S.White
PROTECTIVE PLASTIC CAPS and PLUGS

—ITEM 652—

HEINZE BLOWERS



Type F Blowers

Originally designed for cooling electronic tubes in transmitters, induction heaters and diathermy equipment, Heinze F-2 Blowers have become popular also for advertising displays and similar applications where a small current of air and quiet operation are required.

Characterized by low wattage, neat appearance and light weight. The shaded pole motor will not cause radio interference.

115v AC 60 cycles 15 watts
F2D (double) 20 CFM 3000 RPM (free air)
F2S (single) 10 CFM 3000 RPM (free air)

Heinze Electric Co
685 Lawrence Street. LOWELL, MASS

—ITEM 653—

the SIZE you want... the CAPACITY you want... at the PRICE you want...

Sier-Bath FLEXIBLE GEAR COUPLINGS

the SIZE you want..

Sier-Bath Couplings are smaller, lighter, stronger, simpler in design. Size range is virtually unlimited. Stocked models available from ⅞ to 12 to accommodate most bores on machine and power units. Unusual requirements can be met on order . . . and at low cost!

the CAPACITY you want..

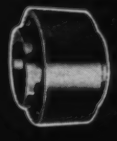
Though smaller and lighter than conventional flange-and-bolt types, Sier-Bath Flexible Gear Couplings have greater horsepower capacity, size for size! Ranges are from 4 to 4500 hp per 100 rpm. Need high speed? Frequent start-stop-reverse? Frequent couple-uncouple? Have cramped quarters? Corrosive atmosphere? Sier-Bath Couplings carry the load!

the PRICE you want..

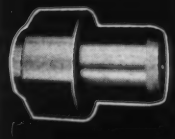
The extremely simple design of Sier-Bath Couplings not only pays dividends in flexibility of application but also results in lower initial costs . . . *averaging 21-percent below other leading brands!* You also save in less down time, longer life, faster assembly and uncouple, elimination of expensive tools.

Get the full story on Sier-Bath Couplings by writing for our complete catalog. We'll be happy to quote on standard or special types, as well.

STANDARD TYPE

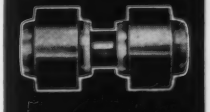


MILL MOTOR TYPE

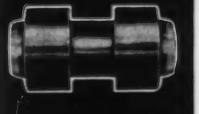


VERTICAL SHAFT TYPE

FLOATING SHAFT TYPE



SPACER TYPE



SPECIAL TYPES:
AIR HOSE CONNECTED • INSULATED • JORDAN • RIGID • CUT-OUT • SLIDING HUB • VERTICAL FLOATING SHAFT • CONTINUOUS LUBRICATED

Sier-Bath
GEAR and PUMP CO., Inc.
9254 HUDSON BLVD., NORTH BERGEN, N. J.
Founded 1905 Member A.G.M.A.

—ITEM 654—

NEW!

highly sensitive precision switch

UNIMAX® Type WHB-5

Movement differential 0.0005 inch max. +

- Low (light) force
- High repeat accuracy
- Long life

This new series of switches is available with three types of over-travel plungers.

Und. Lab. listing: 15 amp. 125/240/480v a-c.

Write for data sheet.

UNIMAX SWITCH

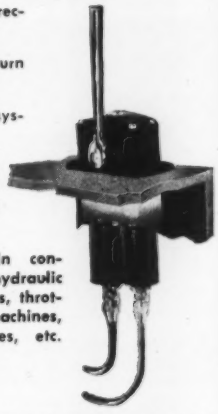
Division The W. L. Maxson Corporation

IVES ROAD, WALLINGFORD, CONNECTICUT

—ITEM 655—

CROWN HYDRA-TROL Remote Control

- Has positive stroke in both directions.
- Does not depend on spring return or outside power sources.
- Immediate synchronization of system in either direction.
- Is a self-contained hydraulic system for positive positioning of remotely-located levers, shafts, and other equipment.



- Valuable in controlling hydraulic valves, winches, throttles, slitting machines, butterfly valves, etc.

Write for bulletin B describing the control and showing its many uses.

Crown Control Division

of

TRIMOUNT INSTRUMENT COMPANY

3119 WEST LAKE STREET • CHICAGO 12, ILLINOIS

—ITEM 656—

Imperial

the world's finest

TRACING CLOTH

In drafting rooms throughout the world Imperial quality is the standard by which fine tracing cloths are judged. This has been true for decades, and Imperial remains the finest tracing cloth because its makers have continued to improve its quality and value.

—ITEM 657—

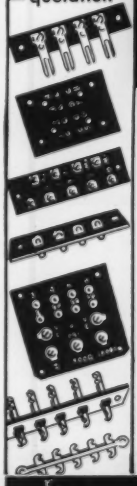
Send your specifications for prompt quotation

Hundreds of standard

JONES TERMINAL PANELS

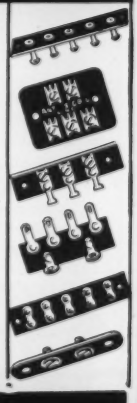
Complete Equipment

FOR SPECIALS



Several pages of Jones Catalog No. 21 illustrate standard and special panels we are constantly producing. Latest special equipment enables us promptly to produce practically any panel required. Send print or description for prices, without obligation. Hundreds of standard terminal strips also listed. Send for Catalog, with engineering drawings and data.

JONES MEANS Proven QUALITY



Jones

HOWARD B. JONES DIVISION

CINCH MANUFACTURING CORPORATION

SUBSIDIARY OF UNITED CARR FASTENER CORP.

—ITEM 658—

For More Information Circle Item Number on Yellow Card—page 19

Industrial rubber products designed to cut your costs

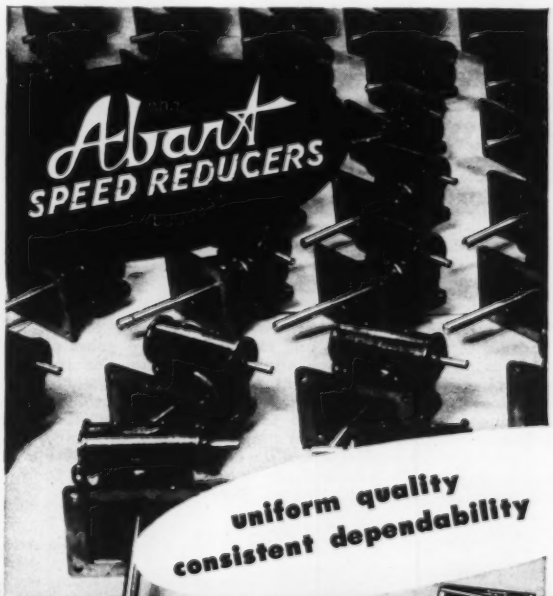
Through every manufacturing step, Cooper research, development and production engineers work as a team, produce as a team, are available as a team to solve your rubber parts problems. Every job gets personal attention. Every job is a challenge to produce precision parts at the lowest possible unit cost. Cooper facilities are the most modern. Cooper delivery schedules are consistently met. Write for your free copy of the "Cooper Story". Learn how Cooper saves time and money for rubber parts users like yourself. Get the facts — no obligation, of course.

Cooper

Send inquiries to INDUSTRIAL RUBBER PRODUCTS DIVISION

Cooper Tire & Rubber Company, Findlay, Ohio

—ITEM 659—

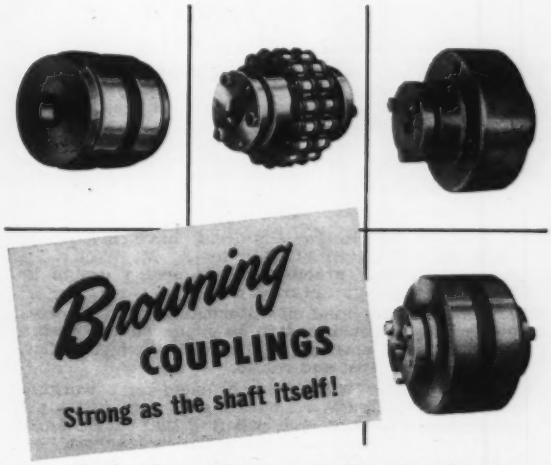


75 types and sizes . . . 1/50 to 168 hp., ratios up to 10,000-1. Specials to order. Request pocket-size Abart Catalog.

ABART GEAR and MACHINE CO.

4821 WEST 16th STREET CHICAGO 50, ILLINOIS

—ITEM 660—



Machined from solid steel or malleable castings, Browning couplings offer compact design and maximum strength. Here you'll find a wide range of flexible, rigid and chain couplings employing Browning's malleable split taper bushing; also fixed bore in the smaller sizes, and a new line of minimum bore chain couplings. It's easy to choose the coupling best suited for each job, when you examine the complete Browning line.

Ask Browning Distributor or write for Catalog V169

Browning MANUFACTURING COMPANY
MAYSVILLE, KENTUCKY

—ITEM 661—

For More Information Circle Item Number on Yellow Card—page 19

New *Bondable* Teflon* and Rulon® *in tape, film, other forms*

Most people thought Teflon and Rulon could never be strongly bonded or cemented to other materials. No solvents affect them — no common chemicals attack them — they are extremely slippery and non-adhesive.

But Dixon is now supplying Bondable Teflon and Rulon and in thin strips and film that may greatly reduce your costs.

Write for 8 page bulletin

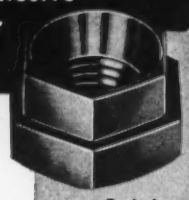
*Dupont's tetrafluoroethylene resin

DIXON Corporation
BRISTOL 3, RHODE ISLAND
Est. 1876

—ITEM 662—

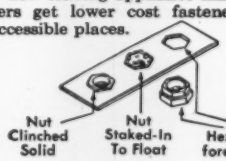
---

use these
GRIPCO CLINCH NUTS
with the exclusive
hex on hex
feature

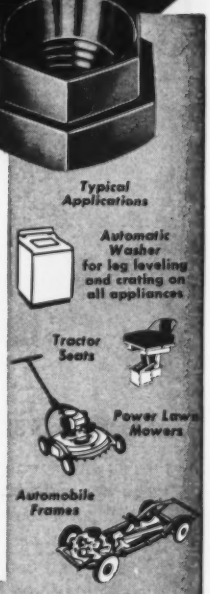


for "fixed" fastenings for "hard-to-reach" or blind assemblies. They wear longer, hold tighter, give greater customer satisfaction.

See how leading appliance manufacturers get lower cost fasteners into inaccessible places.



Gripco Clinch Nuts can be either clinched solid for a rigid application or staked in with a six point staking punch to give a floating effect. This floating effect takes care of misalignment and makes the application of the bolt easier. Gripco clinch nuts can be clinched or staked with stationary or portable hydraulic or air equipment. Details on request. Write for samples and data sheet.



GRIP NUT COMPANY
103 Maple Ave., South Whitley, Ind.

—ITEM 663—

"MECHANICAL SPRINGS"

by A. M. Wahl

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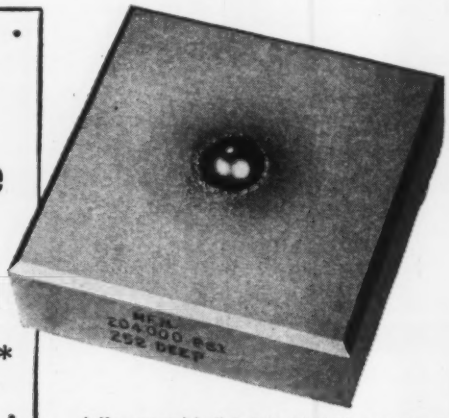

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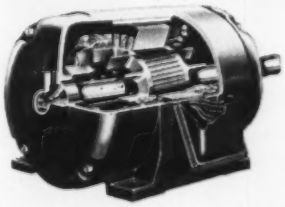

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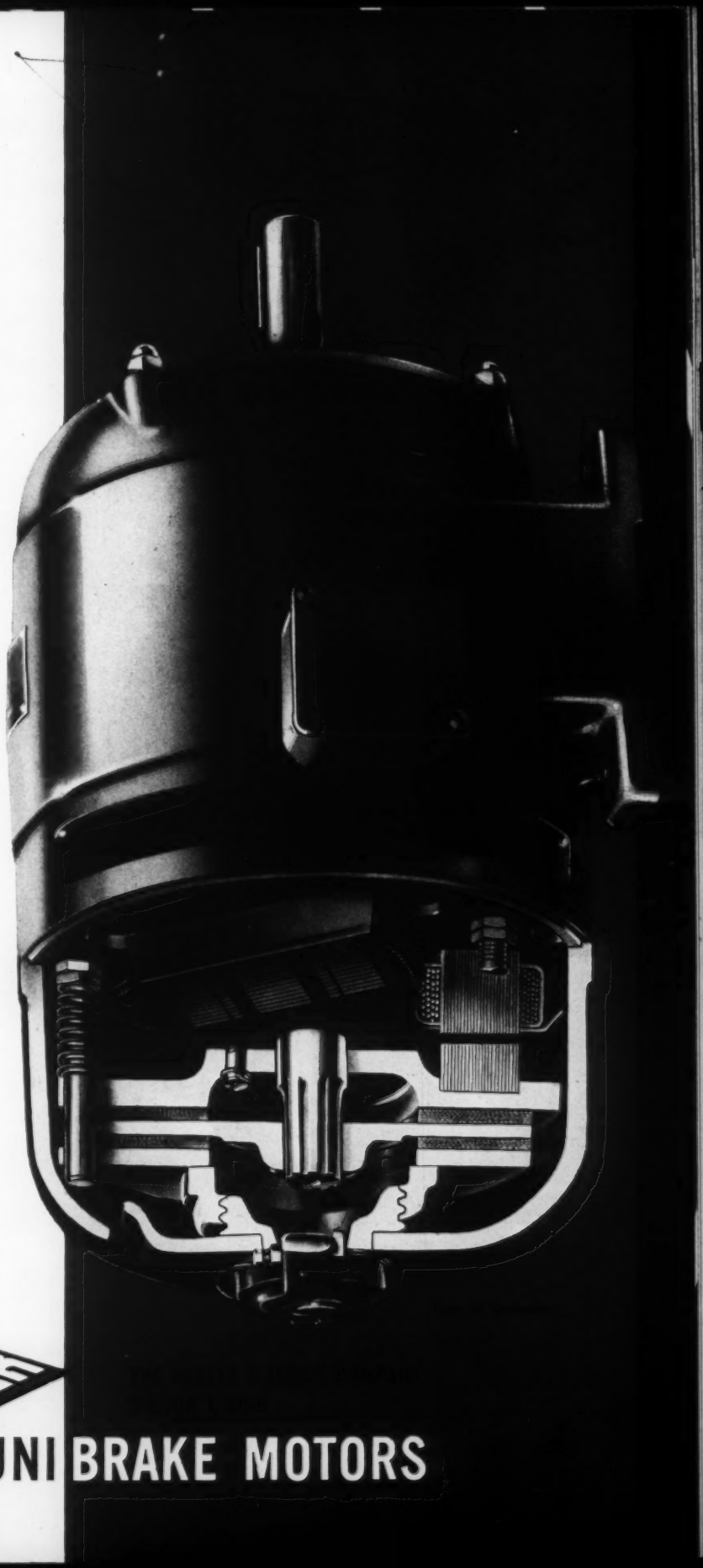

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